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16. ABSTRACT

This report provides the technical data base for the promulgation of effluent limitations guidelines for the Pesticide Chemicals Industry. For the purpose of this study, the Pesticide Industry consists of organic pesticide chemicals manufacturers, metallo-organic pesticide chemical manufacturers, and pesticide chemicals formulator/packagers.

Effluent limitations guidelines for Best Available Technology, Economically Achievable, New Source Performance Standards, Pretreatment Standards for Existing Source and New Sources are promulgated under authority of the amended Clean Water Act. The report addresses 126 priority pollutants as well as nonconventional pesticide pollutants under 40 CFR 455.

Analytical methods for the priority pollutants and nonconventional pesticide are also discussed.

The principal groups of pollutants detected or indicated by the process chemistry evaluation to be present in untreated pesticde process wastewaters were phenols, volatiles (aromatics, halomethanes, and chlorinated ethanes and ethylenes), nitrosamines, dienes, cyanide, metals and pesticides.

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FOR

BEST AVAILABLE TECHNOLOGY, PRETREATMENT TECHNOLOGY, AND NEW SOURCE PERFORMANCE TECHNOLOGY

IN THE

PESTICIDE CHEMICALS INDUSTRY

U.S. ENVIRONMENTAL PROTECTION AGENCY

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ABSTRACT

The purpose of this report is to provide a technical data base for the promulgation of effluent limitations guidelines by the U.S. Environmental Protection Agency for the Pesticide Chemicals Industry. For the purpose of this study, the Pesticide Industry consists of organic pesticide chemicals manufacturers, metallo-organic pesticide chemical manufacturers, and pesticide chemicals formulator/packagers.

Effluent limitations guidelines for Best Available Technology Economically Achievable (BAT), New Source Performance Standards (NSPS), Pretreatment Standards for Existing Sources (PSES) and New Sources (PSNS), are promulgated under authority of the amended Clean Water Act. The report addresses 126 priority pollutants as well as nonconventional pesticide pollutants under 40 CFR Part 455.

Analytical methods were developed, during the verification sampling portion of this study at 16 pesticide manufacturing facilities, using Gas or Liquid Chromatography (GC or LC) for nonconventional pollutant pesticide pollutants. The results of these analyses were evaluated along with data from the EPA-conducted screening sampling programs at 30 plants and data from sampling and analysis by the manufacturers themselves. Additional data from the Organic Chemical Plastics and Synthetic Fibers and the Pharmaceuticals Industrics were also evaluated and utilized. These data were also used in conjuction with process chemistry evaluations of individual pesticide processes to determine the expected priority pollutants associated with manufacturing sources. The process chemistry evaluation was used to confirm data based findings and to make the determinations as to the presence of priority pollutants where no monitoring data were available.

The principal groups of pollutants detected or indicated by the process chemistry evaluation to be present in untreated pesticide process wastewaters were: phenols, volatiles (aromatics, halomethanes, and chlorinated ethanes and ethylenes), nitrosamines, dienes, cyanide, metals, and pesticides.

Treatment units recommended for the control of these pollutants are activated carbon, resin adsorption, hydrolysis, steam stripping, chemical oxidation, metals separation, and biological oxidation. All of these treatment units are currently installed and operating at a significant number of plants within the industry.

Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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SECTION I

EXECUTIVE SUMMARY

This document supports the final Pesticides Effluent Guideline regulation which limits the discharge of pollutants into navigable waters of the United States and into publicly owned treatment works by facilities that manufacture and/or formulate and package pesticide chemicals. The Pesticides Effluent Guideline regulation establishes effluent limitations guidelines at 40 CFR Part 455 based on "best available technology" (BAT), new source performance standards (NSPS) based on "best demonstrated technology" and pretreatment standards for new and existing dischargers (PSES and PSNS). EPA is also promulgating new test procedures for the analysis of nonconventional pesticide pollutants in the Pesticide Chemicals Category under 40 CFR Part 455.

The Pesticides Effluent Guideline regulation is being promulgated under authority of Sections 301, 304, 306, 307, 308, and 501 of the Clean Water Act (the Federal Water Pollution Control Act Amendments of 1972, 33 U.S.C. 1251 et seq., as amended by the Clean Water Act of 1977, P.L. 95-217 (the "Act")).

This regulation is divided into three industrial subcategories:

1. Manufacturers of organic pesticide chemical products, Standard Industrial Classification ("SIC") code 2869.

2. Manufacturers of metallo-organic pesticide chemical products, SIC code 2869.

3. Formulators and packagers of pesticide products, SIC code 2879.

The scope of the regulation under subcategory 1 includes control for priority pollutants in process wastewater from 280 pesticides manufactured by 119 plants. Forty-five of these plants discharge process wastewater to navigable waters, 37 are indirect dischargers, and 50 dispose of wastewater by land disposal, deep well injection, incineration, contract hauling, evaporation ponds, or ocean dumping with no discharge of process wastewater to a POTW or naviagable water. Nine plants generate no wastewater. Subcategory 2 includes all metallo-organic pesticide manufacturers of mercury, copper, cadmium, and arsenic-based products and Subcategory 3 includes pesticide formulator/packagers.

The principal groups of priority pollutants detected or likely to be present in untreated pesticide wastewaters were found to be: volatile aromatics, halomethanes, phenols, cyanides, chlorinated ethanes and ethylenes, metals (copper, mercury and zinc), nitrosamines, dienes, and pesticides. Nonconventional pollutant pesticides were found at concentrations greater than 1 mg/l in approximately 75 percent of all raw untreated pesticide wastewaters sampled and are therefore also regulated where appropriate analytical methods exist.

The major treatment units currently employed by plants in the industry are: biological oxidation, activated carbon, incineration,evaporation, chemical oxidation, hydrolysis, steam stripping, multimedia filtration, resin adsorption, and metals separation. These units, when properly designed and operated, can effectively remove the principal priority pollutants, conventional pollutants, and pesticides found in process wastewaters. Data transfer for steam stripping (organic chemicals and pharmaceutical industries), and for biological treatment systems from the organics industry was utilized in developing regulations for this industry. Wastewater characterization and treatment performance data from these industrial categories were compared with pesticide industry wastewater and treatment performance. It was determined that the waste and wastewater treatment technologies were similiar to those in the Pesticide industry. The Agency therefore used this information in developing regulations for the pesticide industry.

Analytical methods are currently available for detecting 147 nonconventional and priority pollutant pesticides in wastewater. EPA approved 304(h) analytical methods are available for all the remaining priority pollutants (40 CFR Part 136) controlled by this regulation. The Agency is promulgating in 40 CFR Part 455 14 analytical methods for 61 nonconventional pesticide pollutants concurrently with the limits and standards for these compounds. These 61 are a subset of the 147 total for which EPA approved analytical methods are available; analytical methods for the other 86 pesticides are promulgated at 40 CFR Part 136.

The effluent limitation guidelines and standards are summarized in Section II. The analytical methods are discussed in Section X and the specific regulations are discussed in Section XI through XIII. The rationale and methodology for deriving the limits and standards is presented in Sections XIV and XV.

SECTION II

CONCLUSION

The U. S. Environmental Protection Agency has promulgated effluent limitations guidelines and standards for BAT and NSPS, PSES and PSNS for the Pesticide Chemicals Industry based upon the technical information contained in this document, public comments, and other information as appropriate.

This document supports regulations the Agency promulgated for controlling priority pollutants and certain pesticides from 279 organic pesticide chemicals manufacturing processes, from indirect discharging manufacturers of metallo-organic pesticides which contain arsenic, cadmium, copper, and mercury, from new source direct discharging formulator packagers, and from indirect discharging formulator packagers. These different manufacturing processes have been grouped into 3 subcategories as discussed in Section VII.

The Agency is promulgating BAT limits for 34 priority pollutants and pretreatment standards for 28 priority pollutants which, in addition to the zero discharge requirements for two of the subcategories, adequately controls the discharge of 70 priority pollutants known or expected to be associated with the manufacture of pesticide products within these three subcategories. The rationale for selecting these pollutants and for calculating these limits and standards is found in Section IX.

The Agency is also promulgating effluent limitations guidelines and standards for 89 nonconventional pollutant pesticides. The rationale for this is found in Section XIV.

Analytical Methods Summary

The recommended treatment units to achieve these PSES and BAT effluent levels for Subcategory 1 are listed below, and the rationale for this recommendation is found in Section VI.

Steam Stripping
Chemical Oxidation
Evaporation
Metals Separation
Pesticide Removal (Activated Carbon, Resin Adsorption, Hydrolysis)
Biological Oxidation

The treatment/disposal units recommended to achieve the promulgated PSES effluent levels for Subcategories 2 and 3 are listed below, and the rationale for this recommendation is found in Section VI.

Recycle and Reuse
Contract Hauling and Incineration
Mercury Precipitation and Removal by Zinc Dust

BAT effluent limitations for Subcategory 1 Organic Pesticide Chemicals Manufacturers are the values presented in Tables II-1 and II-2 for the priority pollutant and nonconventional pesticide pollutants, respectively. BAT effluent limitations for metallo-organic pesticide manufacturers and formulator/packagers are not necessary since the existing BPT requires zero discharge of process wastewater pollutants. For a detailed discussion of the rationale see Section XI.

NSPS for new direct discharge Subcategory 1 - Organic Pesticide Chemicals Manufacturers is set equal to BAT for the priority pollutant and nonconventional pesticide parameters and to BPT for conventional pollutants and for 48 pesticide products which were previously regulated under BPT. Because of the potential small number of plants, an NSPS is not being established for new direct dischargers in Subcategory 2 - Metallo-Organic Pesticide manufacturers of cadmium, copper, mercury and arsenic-based products. NSPS for new direct dischargers in Subcategory 3 - Pesticide formulator/packagers is set equal to the PSES requirement of no discharge of priority pollutants and pesticide pollutants for which there are analytical methods approved by the Agency. The rationale for this is discussed in Section XII. The nonconventional pesticides covered by this subcategory are listed in Table II-3.

Pretreatment standards for new and existing Subcategory 1 - manufacturing sources (PSNS and PSES) are equal to BAT levels for incompatible pollutants. Pretreatment standards for new and existing Subcategory 3 - formulating/packaging sources have been developed based on new information from that used in establishing the existing BPT regulation and are the same as the NSPS. See Table II-3 for coverage. Pretreatment standards for existing Subcategory 2 - metallo-organic pesticide manufacturers of cadmium, copper, and arsenic-based products are equal to the BPT direct discharge limitations. Because of the potential environmental harm of incineration of mercury waste, the technology basis of the zero requirement for the other types of metallo-organic compounds, contract hauling and incineration, is inappropriate for mercury. The daily maximum PSES standard for mercury is 0.45 mg/l with a monthly average standard of 0.27 mg/l. The rationale for this is found in Section XIII. Because of the small number of potential sources, PSNS is not being established for this subcategory.

TABLE II-1. Priority Pollutant Effluent Limitations and Standards For BAT, NSPS, PSES and PSNS

Priority Pollutants	Maximum for any 1 day (mg/L)	Monthly Average shall not exceed (mg/L)
Benzene(1)	0.057	0.021
Chlorobenzene(1)	0.045	0.023
Toluene(1)	0.035	0.018
1,2-Dichlorobenzene(2)	0.11	0.040
1,4-Dichlorobenzene(2)	0.045	0.018
1,2,4-Trichlorobenzene(2)	0.13	0.055
Methyl bromide	0.15	0.042
Carbon tetrachloride	0.13	0.038
Chloroform	0.075	0.031
Methyl chloride	0.11	0.032
Methylene chloride	0.56	0.16
Cyanide	0.64	0.22
Bis(2-chloroethyl) ether(2)	zero	zero
2,4-Dichlorophenol	0.050	0.023
2,4-Dinitrophenol	0.12	0.034
4-Nitrophenol	0.050	0.019
Pentachlorophenol	0.25	0.15
Phenol(1)	0.040	0.017
Copper	0.27	0.13
Zinc	0.26	0.18
1,2-Dichloroethane(1)	1.0	0.41
Tetrachloroethylene(1)	0.085	0.034
N-nitrosodi-n-propylamine	0.090	0.028
1,3-Dichloropropene(2)	zero	zero
Hexachlorocyclopentadiene	0.13	0.037
a-BHC-Alpha(3)	0.090	0.032
b-BHC-Beta(3)	0.090	0.032
d-BHC-Delta(3)	0.090	0.032
g-BHC-Gamma(3)	0.090	0.032
a-Endosulfan-Alpha(3)	0.090	0.032
b-Endosulfan-Beta(3)	0.090	0.032
Endrin(3)	0.18	0.057
Heptachlor(3)	0.090	0.032
Toxaphene(3)	0.005	0.002

1 BAT/NSPS only

2 Regulated only in those processes in which it is the manufactured product.

3 Limits apply only for PSES, NSPS, and PSNS. BPT limits are established by 455.20(b).

TABLE II-2. Nonconventional Pesticide Pollutant Effluent Limitations and Standards for BAT, NSPS, PSES and PSNS

Pesticide Active Ingredient	Maximum for any 1 day (mg/L)	Monthly Average shall not exceed (mg/L)
Alachlor	0.17	0.041
Atrazine	19.3	7.2
Azinphos methyl(1)	1.4	0.37
Barban	Zero	Zero
Benfluralin	0.20	0.11
Benomyl	13.3	4.1
Bolstar	0.002	0.0008
Bromacil	0.31	0.095
Busan 40	0.44	0.22
Busan 85	0.44	0.22
Butachlor	0.006	0.003
Carbam-s	0.44	0.22
Carbendazim	13.3	4.1
Carbofuran	8.5	2.6
Carbophenothion	0.16	0.076
Chlorpropham(1)	12.2	5.1
Chlorpyrifos	0.16	0.076
Chlorpyrifos methyl	0.16	0.076
Coumaphos	0.16	0.076
2,4-D(1)	3.3	1.5
2,4-D isobutyl ester	3.9	1.7
2,4-D isooctyl ester	3.9	1.7
2,4-DB	0.025	0.014
2,4-DB isobutyl ester	0.041	0.019
2,4-DB isooctyl ester	0.041	0.019
DBCP	1.6	0.78
Demeton	0.17	0.061
Demeton-o(1)	0.14	0.046
Demeton-s(1)	0.14	0.046
Diazinon(1)	0.15	0.069
Dichlofenthion	0.15	0.071
Dichlorvos	0.021	0.007
Dinoseb	0.79	0.42
Dioxathion	0.16	0.076
Disulfoton(1)	0.82	0.25
Diuron(1)	0.090	0.050
Ethalfluralin	0.40	0.21
Ethion	0.15	0.071
Fensulfothion	2.6	0.85
Fenthion	0.91	0.38

TABLE II-2. Nonconventional Pesticide Pollutant Effluent Limitations and Standards for BAT, NSPS, PSES and PSNS
(Continued Page 2 of 3)

Ferbam	1.2	0.39
Fluometuron	0.054	0.030
Glyphosate	130.	32.
Isopropalin	0.20	0.11
KN methyl	0.44	0.22
Linuron(1)	0.056	0.031
Malathion(1)	0.15	0.071
Mancozeb	1.2	0.39
Maneb	1.2	0.39
Metham	0.44	0.22
Methomyl	30.0	9.7
Metribuzin	1.6	0.48
Mevinphos	0.22	0.074
Naled	0.31	0.16
Neburon(1)	0.090	0.050
Niacide	1.2	0.39
Oxamyl	25.7	9.3
Parathion Ethyl(1)	0.014	0.004
Parathion Methyl(1)	0.014	0.004
PCNB(1)	0.21	0.064
PCP salt	4.7	1.0
Phorate	0.15	0.071
Profluralin	0.005	0.003
Prometon	3.7	1.4
Prometryn	19.3	7.2
Propachlor	0.030	0.012
Propazine	19.3	7.2
Propham(1)	12.5	3.8
Propoxur(1)	8.5	2.6
Ronnel	0.16	0.076
Silvex(1)	1.9	0.79
Silvex isooctylester	zero	zero
Silvex salt	zero	zero
Simazine	19.3	7.2
Simetryne	3.7	1.4
Stirofos	0.031	0.015
Swep(1)	12.2	5.1
2,4,5-T(1)	1.9	0.79
Terbacil	30.3	9.6
Terbufos	0.15	0.071
Terbuthylazine	19.3	7.2
Terbutryn	19.3	7.2
Tributyltin benzoate	zero	zero
Trichloronate	0.16	0.076

TABLE II-2. Nonconventional Pesticide Pollutant Effluent Limitations and Standards for BAT, NSPS, PSES and PSNS (Continued Page 3 of 3)

Trifluralin(1)	0.043	0.023
Vancide 51Z	zero	zero
Vancide 51Z dispersion	zero	zero
ZAC	1.2	0.39
Zineb	1.2	0.39

1. Limits apply only for PSES, NSPS, and PSNS. BPT limitations are established by 455.20(b).

TABLE II-3. Pesticides Regulated by PSES, NSPS, and PSNS When Formulated and Packaged

1. Alachlor
2. Aldrin
3. Ametryn
4. Aminocarb
5. AOP
6. Atraton
7. Atrazine
8. Azinphos methyl
9. Barban
10. Benfluralin
11. Benomyl
12. Bentazon
13. a-BHC-Alpha
14. b-BHC-Beta
15. c-BHC-Delta
16. y-BHC Gamma (Lindane)
17. Bis(2-chloroethyl)ether
18. Bolstar
19. Bromacil
20. Busan 40
21. Busan 85
22. Butachlor
23. Captan
24. Carbam-S
25. Carbaryl
26. Carbendazim
27. Carbofuran
28. Carbophenothion
29. Chlordane
30. Chlorobenzene
31. Chlorobenzilate
32. Chloropropham
33. Chloropyrifos
34. Chloropyrifos methyl
35. Coumaphos
36. Cyanazine
37. 2,4-D and its salts and esters
38. 2,4-DB
39. 2,4-DB isobutyl ester
40. 2,4-DB isooctyl ester
41. DBCP
42. 4,4'-DDD

TABLE II-3. Pesticides Regulated by PSES, NSPS, and PSNS When Formulated and Packaged (Continued Page 2 of 3)

43. 4,4'-DDE
44. 4,4'-DDT
45. Deet
46. Demeton-O
47. Demoton-S
48. Demeton
49. Diazinon
50. Dicamba
51. Dichlofenthion
52. Dichloran
53. 1,2-Dichlorobenzene
54. 1,4-Dichlorobenzene
55. 1,2-Dichloropropane
56. Cis - 1,3-Dichloropropene
57. trans - 1,3-Dichloropropene
58. 1,3-Dichloropropene
59. Dichlorvos
60. Dicofol
61. Dieldrin
62. Dimethyl phthalate
63. Dinoseb
64. Dioxathion
65. Disulfoton
66. Diuron
67. Endosulfan I
68. Endosulfan II
69. Endosulfan sulfate
70. Endrin
71. Endrin aldehyde
72. Ethalfluralin
73. Ethion
74. Etridiazole
75. Fensulfothion
76. Fenthion
77. Fenuron
78. Fenuron - TCA
79. Ferbam
80. Fluometuron
81. Glyphosate
82. Heptachlor
83. Heptachlor epoxide
84. Hexachlorobenzene
85. Hexazinone

TABLE II-3. Pesticides Regulated by PSES, NSPS, and PSNS When Formulated and Packaged (Continued Page 3 of 3)

86. Isodrin
87. Isopropalin
88. KN Methyl
89. Linuron
90. Malathion
91. Mancozeb
92. Maneb
93. Mephosfolan
94. Metham
95. Methiocarb
96. Methomyl
97. Methoxychlor
98. Methylbromide
99. Metribuzin
100. Mevinphos
101. Mexacarbate
102. Mirex
103. Monuron
104. Monuron - TCA
105. NABAM
106. Naled
107. Napthalene
108. Neburon
109. Niacide
110. Oxamyl
111. Parathion methyl
112. Parathion ethyl
113. PCNB
114. Pentachlorophenol ("PCP")
115. PCP Salt
116. Perthane
117. Phorate
118. Profluraline
119. Prometon
120. Prometryn
121. Propachlor
122. Propazine
123. Propham
124. Propoxur
125. Ronnel

TABLE II-3. Pesticides Regulated by PSES, NSPS, and PSNS When Formulated and Packaged (Continued Page 4 of 3)

126. Secbumeton
127. Siduron
128. Simazine
129. Simetryne
130. Stirofos
131. Strobane
132. Swep
133. 2,4,5-T
134. 2,4,5-TP (Silvex) and its salts and esters
135. Terbacil
136. Terbufos
137. Terbuthylazine
138. Terbutryn
139. Toxaphene
140. Triadimefon
141. Trichlorobenzene
142. Trichloronate
143. Tricyclazole
144. Trifluralin
145. ZAC
146. Zineb
147. Ziram

In addition Vancide 51Z, Vancide 51Z dispersion, and metallo-organic active ingredients containing mercury, cadmium, arsenic, copper, or tin.

SECTION III

INTRODUCTION

The Federal Water Pollution Control Act Amendments

The Federal Water Pollution Control Act (the Act) Amendments of 1972, 33 USC 1251 et seq., stated the national goal of attaining by July 1, 1983, a water quality which provides for the protection and propagation of fish and shellfish, for recreation in or on the nation's waters, and the goal of eliminating the discharge of pollutants into navigable waters by 1985.

Purpose and Authority

The Federal Water Pollution Control Act Amendments of 1972 established a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters," Section 101(a). Existing industrial dischargers were required to achieve "effluent limitations requiring the application of the best practicable control technology currently available" ("BPT"), Section 301(b)(1)(A); these dischargers were required to achieve "effluent limitations requiring the application of the best available technology economically achievable... which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants" ("BAT"), Section 301(b)(2)(A). New industrial direct dischargers were required to comply with Section 306 new source performance standards ("NSPS"), based on best available demonstrated technology; and new and existing dischargers to publicly owned treatment works ("POTW") were subject to pretreatment standards under Sections 307(b) and (c) of the Act. While the requirements for direct dischargers were to be incorporated into National Pollutant Discharge Elimination System (NPDES) permits issued under Section 402 of the Act, pretreatment standards were made enforceable directly against dischargers to POTW (indirect dischargers).

Although Section 402(a)(1) of the 1972 Act authorized the setting of requirements for direct dischargers on a case-by-case basis, Congress intended that for the most part control requirements would be based on regulations promulgated by the Administrator providing guidelines for effluent limitations setting forth the degree of effluent reduction attainable through the application of BPT and BAT. Sections 304(c) and 306 of the Act required promulgation of regulations for NSPS, and Sections 304(f), 307(b), and 307(c) required promulgation of regulations for pretreatment standards. In addition to these regulations for designated industry categories, Section 307(a) of the Act required the Administrator to develop a list of toxic pollutants and promulgate effluent standards applicable to all dischargers of toxic pollutants. Finally, Section 501(a) of the Act authorized the Administrator to prescribe any additional regulations "necessary to carry out his functions" under the Act.

The EPA was unable to promulgate many of these regulations by the dates contained in the Act. In 1976, EPA was sued by several environmental groups, and in a settlement of this lawsuit EPA and the plaintiffs executed a "Settlement Agreement" which was approved by the Court. This Agreement required EPA to develop a program and adhere to a schedule for promulgating BAT effluent limitations guidelines, pretreatment standards, and new source performance standards for 65 "priority" pollutants and classes of pollutants for 21 major industries. See Natural Resources Defense Council, Inc. versus Train, 8 ERC 2120 (D.D.C. 1976), modified 12 ERC 1833 (D.D.C. 1979), modified by orders dated October 26, 1982, August 2, 1983, January 6, 1984, July 5, 1984 and January 7, 1985.

On December 27, 1977, the President signed into law the Clean Water Act of 1977. Although this law makes several important changes in the Federal water pollution control program, its most significant feature is its incorporation of several of the basic elements of the Settlement Agreement program for toxic pollution control. Sections 301(b)(2)(A) and 301(b)(2)(C) of the Act now require the achievement of effluent limitations requiring application of BAT for "toxic" pollutants, including the 65 "priority" pollutants under 307(a) of the Act. Likewise, EPA's programs for new source performance standards and pretreatment standards are now aimed principally at toxic pollutant controls. Moreover, to strengthen the toxics control program Section 304(e) of the Act authorizes the Administrator to prescribe "best management practices" ("BMPs") to prevent the release of toxic and hazardous pollutants from plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw material storage associated with, or ancillary to, the manufacturing or treatment process.

In keeping with its emphasis on toxic pollutants, the Clean Water Act of 1977 also revised the control program for nontoxic pollutants. Instead of BAT for "conventional" pollutants identified under Section 304(a)(4) (including biochemical oxygen demand, suspended solids, fecal coliform and pH), the new Section 301(b)(2)(E) requires achievement of "effluent limitations requiring the application of the best conventional pollutant control technology" ("BCT"). The factors considered in assessing BCT for an industry include the cost of attaining a reduction in effluents and the effluent reduction benefits derived compared to the costs incurred by and the effluent reduction benefits from a publicly owned treatment works (Section 304(b)(4)(B)). For nontoxic, nonconventional pollutants, Sections 301(b)(2)(A) and (b)(2)(F) require achievement of BAT effluent limitations within three years after their establishment but not later than July 1, 1987.

The purpose of these regulations is to provide effluent limitations guidelines for BAT, and to establish NSPS, pretreatment standards for existing sources (PSES), and pretreatment standards for new sources (PSNS), under Sections 301, 304, 306, 307, and 501 of the Clean Water Act for the pesticides manufacturing and formulating/packaging industry.

SCOPE OF STUDY

Types of Products Covered

This study covers the manufacturing of pesticide active ingredients listed in Section XX--Appendix 2 of this report. The BPT regulation established effluent limitations for the pesticide active ingredient in only 49 pesticide wastewaters because there were available Agency approved analytical methods for only those 49 pesticides. Two of these pesticides, aldrin and dieldrin, have been banned from manufacture and use by EPA and are also covered by regulations promulgated under 8307 of the Act. Forty-seven pesticides which were previously regulated which were under BPT for pesticide parameters are combined with 223 pesticides not previously regulated by BPT for pesticide paramater. The manufacturing of a total of 279 pesticides are now included in the scope of this regulation. These 279 pesticides were the pesticides of most commerical importance on the 1978 FIFRA regulation list after removing compounds such as copper sulfate which are covered by other regulations.

Because of the lack of data or an analytical method for most of the 279 pesticides, many of the pesticide pollutants are not specifically limited in today's regulation. Specific effluent limitations are promulgated for only 89 individual pesticides (Table II-2). However, priority pollutants associated with the 280 pesticides are controlled by today's regulations.

The formulation of 147 organic chemical pesticide active ingredients also: vancide 51Z, vancide 51Z dispersion, and metallo-organic pesticides containing arsenic, cadmium, copper, mercury, and tin (for which there are approved analytical methods) into liquids, dusts and powders, or granules, and their subsequent packaging in a marketable container is also covered under this study for new and existing indirect dischargers. The manufacture of mercury, cadmium, copper, and arsenic-based pesticides is addressed for new and existing indirect dischargers. Direct discharge of wastewaters from these metallo-organic pesticides and formulating/packaging facilities was prohibited by BPT regulations.

The definition of a pesticide differs among the governmental, industrial, and scientific communities. For the purposes of this regulation a pesticide is defined as "any technical grade ingredient intended to prevent, destroy, repel, or mitigate any pest, subject to the following categories":

Product Classes Generally Included in Regulation

Insecticides
Herbicides
Fungicides
Nematicides
Rodenticides
Acaricides
Algicides
Miticides
Molluscicides

Avicides
Slimicides
Piscicides
Ovicides
Defoliants
Desicants
Repellents
Synergists
Botanicals
Fumigants

Product Classes Generally Not Included in Regulation*

Bactericides
Inorganic Pesticides
Plant Growth Regulators
Sex Attractants
Quaternary Ammonium Salts
Microbials
Wood Preservatives**
Sanitizers
Disinfectants
Chemosterilants

Pesticides produced outside the United States
Organic, Pharmaceutical, Plastic and Synthetic, or Other Industry
Compounds Regulated Elsewhere
Pesticides Produced in Limited quantities at stand alone research facilities

* Specific products not included are itemized in the administrative record for the regulation.

** The wood preservative pentachlorophenol is included due to its high-volume production.

Compounds defined in Section XX--Appendix 1 as "priority pollutant pesticides" are known hereafter as priority pollutants, whereas all other pesticides are referred to as "nonconventional pollutant pesticides."

Definition of Wastewaters Covered

This study assesses only process wastewater associated with the manufacture or formulating/packaging of pesticide active ingredients. As shown in the Glossary, Section XIX, the definition of "process wastewater" adopted is . . . any aqueous discharge which results from or has had contact with the final synthesis step in the manufacturing of pesticide active ingredients, or with the formulating/packaging of those active ingredients, to include the following:

1. Final synthesis reaction wastewater or water used directly in the process.

2. Wastewater from vessel/floor washing in the immediate manufacturing and formulating/packaging area.

3. Stormwater runoff from the immediate manufacturing and formulating/packaging process area or, the transportation loading area.

4. Wastewater from air pollution or ventillation scrubbers utilized in the manufacturing process or in the immediate manufacturing and formulating/packaging area.

5. Potentially contaminated process wastestreams that are the result of the washing of clothing, safety equipment etc. or the safety testing of packaging containers.

Wastewater which is not contaminated by the process, such as boiler blowdown, cooling water, sanitary sewage, or storm water from outside the immediate manufacturing area, is not included in the definition of process wastewater.

Status of Pesticide Intermediates

The manufacture of pesticide intermediates is not within the scope of this regulation because they are generally organic or inorganic compounds which have multiple uses, not just in the manufacture of pesticides covered in this document. As noted in Section XIX, Glossary, the definition of "manufacture of pesticide intermediates" adopted is . . . the manufacture of materials resulting from each reaction step in the creation of pesticide active ingredients, except for the final synthesis step, and are, in most cases, nonconventional pollutants. In the pesticide industry these intermediates may be purchased from other manufacturers, produced on-site in the exact quantities required for pesticide production, or produced on-site in excess of that required.

Process wastewater resulting from the production of pesticide intermediates by use of a separate chemical manufacturing process which is not an integral part of the pesticides manufacturing process, where the intermediate is a manufactured inorganic or organic chemical, are covered by either the inorganic or organic chemicals effluent guideline regulations. If, however, these inorganic or organic processes are not covered by other industrial regulations, the permit writer may on a case-by-case basis write Best Professional Judgment (BPJ) permits.

Effect of Previous Regulations

BPT Effluent Limitations

In general, the BPT technology level represents the average of the best existing performances of plants of various ages, sizes, processes, or other common characteristics. The factors considered in defining best practicable control technology currently available (BPT) include the total cost of applying such technology in relation to the effuent reductions derived from such application, the age of equipment and facilities involved, the process employed, nonwater quality environmental impacts (including energy requirements) and other factors the Administrator considers appropriate (section 304(b)(1)(B)). The Agency balances the total cost of applying the technology against the effluent reduction achieved. Where existing performance is uniformly inadequate, BPT may be transferred from a different subcategory or category.

Final BPT regulations for direct dischargers in the Pesticide Chemicals Industry were published in the Federal Register on April 25, 1978, and were amended on September 29, 1978. The effects of these regulations on the current study are as follows:

1. Several pesticides and classes of pesticides (such as triazines) were excluded from the BPT regulations. This study addresses nonconventional pesticide pollutant and priority pollutant removal technology for both direct and indirect dischargers for many of these processes (see Section XX--Appendix 3 for a list of previously excluded pesticides).

2. Forty-nine pesticide parent compounds were specifically identified and regulated in the BPT regulation for direct dischargers because EPA had promulgated analytical methods available for the pesticide parameters. COD, BOD, TSS, and pH were also regulated for these compounds. This study addresses the priority pollutants for direct and indirect dischargers which are present in any of these pesticides manufacturing processes (see Section XX--Appendix 3 for a list of these 49 pesticides), and addresses most of the present pesticides for the indirect dischargers. There are exceptions in that for 5 of the 49 previously regulated pesticides; Aldrin, dieldrin, DDT, DDD, and DDE, coverage under this regulation is not required because discharge of wastewater from the manufacture and/or formulation of these pesticides was prohibited by Section 307(a) of the Clean Water Act published in the Federal Register, January 12, 1977 (40 CFR Part 129). The same rule established acceptable levels for direct discharges for the two pesticide parameters endrin and toxaphene (see January 12, 1977 Federal Register). Process wastewaters from the manufacturing of endrin and toxaphene will be subject to BAT/PSES regulations for associated priority pollutants (direct and indirect discharge) and PSES regulations for the pesticide pollutants endrin and toxaphene (indirect discharge).

3. All the 280 pesticides covered by this regulation except for 25 which were specifically excluded under BPT were regulated under BPT for the direct discharge of BOD, COD, TSS, and pH; See Appendices 2 and 3, respectively. Therefore this study addresses the nonconventional pollutant pesticides and priority pollutants for products in this group being directly or indirectly discharged.

4. The metallo-organic pesticides with mercury, cadmium, copper, or arsenic bases were assigned a zero-discharge limitation under BPT for direct dischargers. This study addresses process wastewater pollutants from manufacturing these metallo-organic pesticides that are discharged to POTWs which are subject to PSES regulations.

5. Formulators/packagers of pesticide active ingredients that discharge wastewater to navigable waters were assigned a zero discharge limitation under BPT. This study addresses formulators/packagers that discharge process wastewater to POTWs which are subject to PSES and PSNS regulations.

BAT Effluent Limitations

In general, the BAT technology represents the best treatment system available economically achievable by plants within each subcategory of the industry. The Act established BAT as the principal national means of controlling the direct discharge of toxic and nonconventional pollutants to navigable waters. The factors considered in assessing best available technology economically achievable (BAT) include the age of equipment and facilities involved, the process employed, process changes, and nonwater quality environmental impacts (including energy requirements) (section 304(b)(2)(B)). The Agency retains considerable discretion in assigning the weight to be accorded these factors. As with BPT, uniformly inadequate treatment system performance within an industry may require transfer of a BAT treatment technology from a different industry subcategory or category. BAT may include process changes or internal controls, even when these technologies are not common industry practice.

New Source Performance Standards

New Source Performance Standards (NSPS) are based on the best available demonstrated technology. New plants have the opportunity to install the best and most efficient production processes and wastewater treatment technologies, and, therefore, Congress directed EPA to consider the best demonstrated process changes, in-plant controls, and end-of-pipe treatment technologies to reduce pollution to the maximum extent feasible.

Pretreatment Standards for Existing Sources

Pretreatment Standards for Existing Sources (PSES) are designed to prevent the discharge of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of well-operated publicly owned treatment works (POTW) with secondary treatment installed. Compliance must be achieved within three years of the date of promulgation.

The Act requires pretreatment for toxic pollutants that pass through the POTW in amounts that would violate direct discharger effluent limitations or interfere with the POTW's treatment process or chosen sludge disposal method. The legislative history of the 1977 Act indicates that pretreatment standards are to be technology-based, analogous to the best available technology for removal of toxic pollutants. EPA has generally determined that there is pass through of pollutants if the percent of pollutants removed by a well-operated POTW achieving secondary treatment is less than the percent removed by the BAT model treatment system. The general pretreatment regulations, which serve as the framework for the categorical pretreatment regulations are found at 40 CFR Part 403. 43 FR 27736 (June 26, 1978); 46 FR 9462 (January 28, 1981).

Pretreatment Standards for New Sources

Like PSES, Pretreatment Standards for New Sources (PSNS) are to prevent the discharge of pollutants which pass through, interfere with, or are otherwise incompatible with the operation of the POTW. PSNS are to be issued at the same time as NSPS. New indirect dischargers, like new direct dischargers have the opportunity to incorporate the best available demonstrated technologies. The Agency considers the same factors in promulgating PSNS as it considers in promulgating PSES.

Wastewater Sampling and Data Acquisition

Data has been obtained over a long period of time, and from many sources. The first data source consisted of a screening sampling program conducted by EPA regions and private contractors. A verification sampling program was then conducted to accurately define the source and level of pollutants in pesticide wastewaters. Following verification sampling, an industry self-sampling program was instituted. Additional priority pollutant and nonconventional pesticide data was also received directly from manufacturers as a result of various 308 surveys conducted over a seven year period. The final source of data consists of information from the Organic Chemicals, Plastics and Synthetic Fibers and Pharmaceuticals industries as well as information received from the pesticide industry from comments to the November 30, 1982 proposed regulations (47 FR 33492) and the notices of new information, dated June 13, 1984 (49 FR 24492) and January 24, 1985 (50 FR 3366) and the proposed analytical methods published February 10, 1983.

METHODOLOGY

A brief description of the methodology used in the conduct of this study is given below to provide a better understanding of the organization and logic of this report.

Definition of the Industry

The first task upon commencing this project was to accurately define the pesticide producers which would be covered. A list of pesticides potentially manufactured was developed from the following sources:

1. Existing records from the BPT study;

2. Listing of pesticide facilities made available through the EPA/Office of Pesticides Programs;

3. _1977 Director of Chemical Producers_, Stanford Research Institute;

4. _Pesticides Process Encyclopedia_, Marshall Sittig, 1967;

5. _Source Assessment: Prioritization of Stationary Water Pollution Sources_, U.S. EPA, 1977 (List of 108 Environmentally Significant Pesticides); and

6. _1977 Chemical Economics Handbook--Pesticides_, Stanford Research Institute.

As a result of this initial review, a total of 167 potential manufacturers were identified.

A total of 279 pesticides were selected after a review of the 600 plus registered active ingredients to determine which should be covered under the 1976 consent decree. Many of the registered active ingredients are products that are outside of the the agricultural pesticide chemicals category. They include inorganic compounds (sodium borate), organic compounds whose primary use is other than pesticides (formaldehyde), products made exclusively outside the United States, products previously excluded from regulations under paragraph 8 of the consent decree, (e.g. soaps and detergents) and products that are regulated under other industrial categories, such as inorganic chemicals, adhesives and sealants. The specific reasons for exclusions of products are included in the proposal record in Section II B.1. Products included are pesticides which have significant production or commercial use. Research facilities were excluded because the pesticides produced for research were not produced in significant quantities.

Manufacturers 308 Survey

A 308 Survey was drafted by EPA and reviewed and approved by the Effluent Guidelines Subcommittee of the National Agricultural Chemicals Association (NACA). After approval was obtained from the Office of Management and Budget (OMB #158-R0160), the survey was distributed in July 1978. A copy of OMB# 158-R0160 is found in Appendix 5, Section XX of the proposed development document (EPA 400/1-82/079b). The purpose of this survey was to obtain basic data concerning manufacturing, disposal, and treatment, as well as to identify potential sources of priority pollutants. For those plants previously contacted during BPT, much of the basic data was already available and was not requested a second time. Instead, specific questions concerning the conventional and nonconventional pollutants were asked along with the general priority pollutant portion of the survey. Responses were received during August, September, and October 1978. Based on this information 119 plants were selected for further study. Approximately 90 follow-up 308 letters were sent during the months of March, April, and May 1979 to clarify the record on each plant as well as to request specific priority pollutant data and the results of any available treatability studies. During the months of March and April 1980 308 letters were sent to over 50 selected plants requesting specific data to be used primarily for statistical analysis. These 308 survey results were updated by the respondents in comments and data received in response to the November 30, 1982 proposal and June 13, 1984 NOA. Additional information and data were received from respondents through telephone calls and letters after close of the the NOA comment period, to clarify the comments.

Formulator/Packagers 308 Survey

EPA proposed a PSES regulation in November 1982 requiring no discharge of process wastewater pollutants to navigable waters, applied to all wastewaters from the formulation and packaging of all pesticides (see tables on page III-6). The proposed PSES regulation was similar to the previously promulgated BPT regulation for direct discharging PFP plants. The same data base was used to support the proposed zero discharge PSES standard.

EPA conducted a telephone survey of a representative portion of the entire pesticide formulators and packagers industry registered with EPA under the Federal Insecticide Fungicide and Rodenticide Act (FIFRA).

These surveys identified PFP facilities which formulated or packaged agricultural and/or household pesticides and which also discharged process wastewater to a POTW. A copy of this survey is provided in Section XX - Appendix 4.

A questionnaire was then sent to the facilities so identified, under authority of §308 of the Clean Water Act, requesting detailed economic, production, and process information (OMB 2040-0041). A copy of this questionnaire is also provided in Section XX - Appendix 5. Facilities which formulated or packaged products other than agricultural and/or household pesticides, such as sanitizers, disinfectants, inorganics, and surface active agents, were excluded from the questionnaire survey. After evaluating this new data we then notified the public of our new data in a June 13, 1984 notice of availability ("NOA") and summarized the results.

Screening Sampling

A screening, sampling, and analysis program was conducted during 1977 and 1978 as the first step in determining the source and level of priority pollutants in the pesticides industry. A total of 30 plants were sampled, 27 by EPA Regional Sampling and Analysis teams and the remainder by EPA contractors. These samples were taken and analyzed by GC/MS for the 126 priority pollutants using the March 1977 analytical methods and sampling protocol developed by the Effluent Guidelines program (U.S. EPA, 1977g). Nonconventional pesticides where an analytical method was available were also analyxed these data were used to assist in the selection of plants for verification sampling and in the identification of specific pollutants to be analyzed at those plants.

Verification Sampling Program

An evaluation of existing data as well as 308 Survey responses was used to select 16 plants for the verification sampling and analysis program to develop additional quantitative data on the raw waste and effluent levels of pollutants in the pesticide industry. These 16 plants were selected if they met the following criteria: (1) process chemistry analysis or screening sampling indicated the existence or suspected presence of priority pollutants in the raw waste or treated effluent; (2) the plant employed a potential BAT wastewater treatment technology; and (3) the plant manufactured a variety of pesticide types.

The following procedures were employed at each of the individual plants:

1. An engineering visit was scheduled and conducted. At this visit a comprehensive engineering survey of the plant was made, historical data were reviewed, potential priority pollutant sources were identified, and grab samples were taken of at

least the process intake water, raw process wastewater, and treated effluent. These samples were transferred to the individual contractor laboratories for analysis. An engineering report was filed and provided to plant personnel for review and comment.

2. A sampling plan was prepared which, upon conclusion of laboratory efforts to determine analytical methods, provided the rationale for selection of future sampling sites and parameters along with a step-by-step analytical procedure for each of the pollutants to be measured. A copy of this report was provided to the plant in advance of any further wastewater sampling.

3. A verification sampling visit was scheduled and conducted, consisting of one grab sample and three 24-hour composites taken at each site specified in the sampling plan. Teams of engineers and technicians took samples, preserved them, and shipped them to contractor laboratories for analysis of conventional, nonconventional, and priority pollutants. In some cases plant personnel also collected wastewater from EPA sampling sites or were provided split samples by the EPA contractor during verification sampling visits.

4. A verification sampling report was filed on completion of the laboratory analyses. A copy of this report was provided to the plants for review and comment. The report contained results of analyses, documentation of problems encountered, and evaluation of treatment system performance.

5. A final plant report was prepared for each site visited to include all the above mentioned material, plant correspondence, sampling logs, and final analytical procedures utilized. These reports were also provided to the individual plants for comment.

6. A laboratory data report was prepared for each plant including individual chromatograms, laboratory notebooks, and documentation of all quality control measures employed. GC/MS procedures were used to confirm GC analysis, when specific problems existed, for approximately 10 percent of the verification samples.

Industry Self-Sampling Program

EPA solicited volunteers for self-sampling and self-analysis programs to be conducted for 30- to 45-day periods at specific plant/process waste streams. The purpose of the program was to obtain long term data on selected priority pollutants.

The recommendation for the selection of plants to undergo self-sampling/self-analysis was based on a review of the adequacy of plant data, indicated or detected presence of priority pollutants proposed for regulation, and whether potential BAT technology was currently in place. From this review nine plants were recommended for the self-sampling program. However, only four plants participated in this program.

Data from each of the volunteer plants was received, processed, and evaluated.

Quality Assurance/Quality Control

The entire verification program was designed to be conducted in accordance with a written sampling protocol (ESE, 1979) and within specific analytical Quality Assurance/Quality Control (QA/QC) guidelines (Jayanty, March 1979). The sampling protocol specified methods of container preparation, sample fractioning and preserving, sample transportation, and sample documentation and tracking.

The elements of the QA/QC program were:

1. Preparation of a QA/QC manual which consolidated analytical contractors.

2. Establishment of quality control goals for duplicate and spike analyses; in this case all first day verification samples were duplicated, and all third day samples were spiked and recoveries calculated.

3. Implementation of quality assurance testing for each analytical laboratory. Each contractor was forwarded test samples containing unidentified concentrations (both high and low) of compounds common to two of the plants analyzed by the lab. These samples, prepared in distilled water, were

> analyzed utilizing the same procedures used on actual plant wastewaters. In addition, one sample with identical constituents was sent to all of the analytical contractors for a comparative basis.
>
> The results of these analyses were returned to the QA/QC contractor for comparison with the known concentrations of each parameter as determined by gravimetric measurement. The results of the QA/QC program are available in a series of reports in the proposal administrative record.

The precision and accuracy goals of the QA/QC study were: an overall precision of 25 percent, including sampling, extraction, and GC measurement; and spike recovery equal to or greater than 70 percent.

Audit of Actual Wastewater Analytical Data

After evaluating the results of the QA/QC program, it was decided to audit portions of the actual wastewater analytical data obtained by the verification program. At least 10 percent of the data from each of the four verification contractors was audited by the QA/QC contractor. Since the audit revealed some deviations from protocol, an additional audit took place of the remaining 90 percent of the data. The results of the above-mentioned audits were used to eliminate data deviating from the specified protocols from the data set and the remaining data was incorporated into the data tables found in this report. Data that failed the QA/QC audit were not included in the calculation to develop limits and standards. The data were, however, used in conjunction with the process chemistry review.

Industry Data Provided as Part of Public Comments

Commentors submitted additional information to the Agency in response to the November 30, 1982 proposal and the June 13, 1984 and January 24, 1985 Notices of Availability. The number of commentors to the proposal and the two NOAs were 55, 41, and 25 respectively. The new information submitted included a considerable amount of plant effluent data. Most of this data were composed of corrections on previously submitted flow, raw waste, and treatment system influent and effluent data. Approximately one dozen commentors provided new data on priority pollutants and nonconventional pesticide pollutants to the Agency which significantly affected the final data base and the calculation of long term averages and variability factors used in deriving the final limits. Consequently, the promulgated effluent limitations guidelines reflect these modifications and the submittal of new data.

Process Chemistry Evaluation

Because there are 119 plants in the industry and 16 were sampled during the verification program, an evaluation of each of the pesticide processes not sampled was performed in order to determine which priority pollutants were likely to be present for the industry as a whole. This review was accomplished using the process descriptions, feedstock materials including solvents used, information and products information provided by each plant as part of the 308 Survey response as well as using existing BPT and published technical information on the processes in the literature. EPA determined that pollutants are likely to be present in the process because they are the final manufactured product, used as raw materials, are known impurities in the feed materials, or were reported by-products or impurities of the reaction. The results of this process chemistry evaluation were compared with any available data and confirmed. The results of the process chemistry evaluation of 280 pesticides are presented in Section V. A separate summary report has been prepared with greater detail on the process chemistry review and is in the confidential record. Due to the confidential nature of much of this material, details of each process are in pesticide group reports in the confidential portion of the record (Volume 107 to 110).

Raw Waste Load Summary

All available raw waste load data were gathered and presented in conjunction with the process chemistry evaluation. Representative historical data from BPT, screening data, verification data, and 308 data, are consolidated and summarized in Section V of this document according to groups of priority pollutants as defined in the Glossary, Section XIX.

Treatment Technology Evaluation

Treatment and control technology currently utilized within the pesticide chemicals manufacturing industry were evaluated in terms of its performance in removing priority pollutants and pesticides. Control and treatment technologies routinely accomplishing exemplary removal of specific pollutants in other industrial categories were evaluated to determine whether they would be applicable to the pesticide industry where treatment performance data were either absent or based on an evaluation of the treatment system performance. The Agency concluded there was inadequate treatment of certain pollutants by the pesticide industry. EPA has determined that treatment and control technology from other industrial categories can be transferred to the pesticide industry because the wastewater from these industries are similiar to those in the pesticides industry and the technologies are similarily effective in removing pollutants common to the separate industries. Physical/chemical and biological treatment system performance data were transferred from the OCPSF and pharmaceutical industries for solvents common to all three industries (where raw waste levels are similar). The theory of each technology, full-scale design and operating data, and treatability data are all discussed in Section VI.

Technologies were analyzed to determine their effectiveness in removing each individual or group of priority pollutants and nonconventional pollutant pesticides. Based on this review, flow diagrams describing the individual treatment technology units were developed along with the design parameters and operating criteria which establish what constitutents a well designed and operated treatment system. Data were deleted if they failed to meet editing criterion. This criterion is discussed in chapter VI.

Based on technology evaluations, criteria expressed as percent removal and minimal effluent levels were established for the purpose of determining best performing plants. This criteria provided a performance description of a well designed and operated BAT treatment system. The data from those plants meeting these criteria were then used to develop the final limitations. The discussion of best performing plants is also presented in Section VI.

Subcategorization

Factors such as raw materials, wastewater treatability, prior regulatory status, wastewater characteristics, disposal, manufacturing processes, plant location, age, and size were all considered prior to arriving at the final subcategorization scheme. Based on these evaluations the manufacturing processes for organic pesticide chemicals were placed in one subcategory. The manufacturing processes for metallo-organic pesticide chemicals were placed in a second subcategory and pesticide formulating and packaging was placed in a third subcategory. A further discussion of subcategorization is given in Section VII.

Cost and Energy

As presented in Section VIII, cost curves representing cost as a function of flow were prepared for each of the recommended treatment units. The design parameters used in establishing these cost curves were based on maximum raw waste pollutant concentrations. The cost curves used in this report differ from the curves used in the proposed development document. The design data were updated by the use of new information from the Organic Chemicals, Plastics and Synthetic Fiber (OCPSF) Industry Category for steam stripping and data provided by commentors on both the proposal and the NOA. A reevaluation showed that both steam stripping costs and carbon regeneration costs were previously overestimated for the Pesticides Industry. These cost curves were used to derive plant-by-plant capital, annual, and energy costs. All other cost curves were updated since the proposed development document was published and the revised cost curves are presented in Section VIII.

Nonwater Quality Impact

The potential air and solid waste effects of recommended treatment are discussed in Section VI.

Selection of Pollutant Parameters

The selection of pollutant parameters was based on the toxic pollutant list in the case of priority pollutants as desirbed in Section V. In the case of nonconventional pesticide pollutants it was based on the availability of analytical methods, the presence of these compounds in pesticide wastewaters, and treatment system performance data or data from another pesticide from which a technology transfer of performance could be made.

Selection of Expanded Best Practicable Technology

The Agency proposed expanding the 1978 BPT regulation to establish BPT limitations on BOD, COD, TSS and pH for plants manufacturing 21 of the 23 pesticides and two classes of pesticides which were previously excluded; see Appendix 3 of Section XX. The proposed expanded BPT was based on biological treatment preceded in certain cases by hydroloysis or activated carbon physical/chemical treatment to protect the biological treatment system. The plants which produce these 21 pesticides or classes of pesticides already have this treatment in-place, and are in compliance with limitations which are based on BPJ (Best Professional Judgement) determinations by industrial permit writers. It was therefore concluded that the proposed BPT expansion was not necessary and was therefore not promulgated. The BAT regulation will control the priority pollutants discharged by these plants.

Selection of Best Available Technology

Based on technical feasibility and actual performance data, four levels of treatment were initially considered for the proposed regulations. Level one was based on BPT (pesticide removal by adsorption or hydrolysis followed by biological treatment). Level two included combinations of BPT technologies steam stripping, chemical oxidation, and metals separation as necessary. Level three was based on level 2 technology plus effluent polishing through the use of a dual media filter. Level 4 was based on level 3 plus tertiary activated carbon adsorption for final removal of dissolved organics. The design effluents for each level of treatment were determined. Then, an evaluation of the economic and technical aspects of implementing regulations at the design effluents led to the selection of level 2 as Best Available Technology for the proposed regulation. As discussed in Section XI, the BAT model treatment technology which forms the basis for todays regulation varies depending upon the pollutant.

Selection of NSPS Technology

NSPS is based on consideration of process modifications, in-plant controls, and end-of-pipe technology, as defined in Section XII. NSPS is equal to BAT for the organic pesticide chemical manufacturer's subcategory and equal to PSES for the PFP subcategory but is excluded for the metallo-organic subcategory because of the potential small number of sources.

Selection of Pretreatment Standards Technology

The PSES technology is the same as BAT for many of the NCPs and two priority pollutants controlled in the manufacturer's subcategory because of the need for biological treatment. Zero discharge of process wastewater pollutants requirement for the other two subcategories except in the case of mercury for subcategory 2 was derived based on the existing BPT requirement confirmed as appropriate by the additional analysis which were performed. The PSES model technologies are identified and discussed Section XIII.

Selection of BAT and NSPS Effluent Limitations and Pretreatment Standards for Existing (PSES) and New Sources (PSNS)

The data from best performing wastewater treatment plants presented in Section VI was used to determine pollutant long-term averages and variability factors. From these results, which are presented in Section XIV and XV, the daily and monthly maximum effluent limitations and pretreatment standards for each regulated pollutant were calculated, such that they can be achieved by well-operated plants a high proportion of the time.

Environmental Assessment

As discussed in Section XVI, an assessment of the environmental effects of implementing the promulgated standards and limitations is presented in a separate document prepared by EPA/Monitoring and Data Support Division. This assessment projects the significance of post-regulatory discharges of nonconventional pesticides and priority pollutants on human health, aquatic life, and the operation of POTWs.

Appendices

Appendices XX-1 through XX-10 are provided to list important reference data too lengthy for the body of this report and pollutant data that are helpful in interpreting the report.

SECTION IV

INDUSTRY PROFILE

ECONOMIC AND INVENTORY DATA

This section discusses the structure of the Pesticide Chemicals Industry and presents economic and inventory data related to this industry.

The pesticide chemicals industry includes plants which formulate and package pesticide active ingredients. Most formulator/ packagers generate little or no wastewater. However, wastewaters that are generated through equipment washes, floor washes, and air pollution control can contain high concentrations of pollutants. Formulator/packager information is presented as a subsection to this section.

Information presented in this section includes 119 pesticide manufacturing plants currently producing 248 pesticide active ingredients. An additional 32 pesticide active ingredients have been included in the scope of this study but are not currently manufactured. There is one known manufacture of metallo-organic pesticide chemicals with an indirect discharge and approximately 1264 pesticide formulator/packagers.

Pesticide Utilization

The major classes of pesticides are presented in Table IV-1. The total 1977 production volume for reported pesticides within the scope of this study was approximately 1.6 billion pounds according to the Industry 308 Survey. Although published data on industry output lag as much as three to four years, it is estimated that this production volume accounts for more than 95 percent of the compounds of interest. A 1980 article (Chemical Week, May 7, 1980) estimates pesticide shipments of 1.7 billion pounds in 1978. The relative percentage of production for pesticide classes is consistent with prior data; however, a trend toward increasing volumes of insecticide and decreasing volumes of herbicide production is indicated. The number of products within each class of pesticides conforms roughly to the volume produced for each class.

As reported by Eichers, et al. (1978), the total pesticide use for farm and nonfarm purposes in 1976 was estimated at 1.67 billion pounds. Farmers used an estimated 661 million pounds of all pesticides, a 38 percent increase over 1971. In 1976 a total of 394 million pounds of herbicides was applied by farmers, an increase of 76 percent over 1971. The leading crop herbicides used by farmers in 1976 were atrazine (90 million pounds) and alachlor (89 million pounds). In 1976, 162 million pounds of insecticides were used on 74.9 million acres of major field crops, hay, pasture, and rangeland. The organochlorine insecticides accounted for 60 percent of all farm crop insecticides in 1966, 46 percent in 1971, and 29 percent in 1976. The increased use in 1976 of organophosphate and carbamate insecticides helped to reduce the organochlorine residue problems but has increased potential hazards to farm workers. Although there has been a shift away from organochlorines, toxaphene was the leading insecticide used in 1976, at 30.7 million pounds. Toxaphene has subsequently been dropped from production in 1984. The major fungicides used in 1976 were chlorothalonil and copper compounds. Approximately 43.2 million pounds (4.1 pounds per acre) of fungicides were applied in 1976. The overall growth rate of pesticide use between 1971 and 1976 was 40 percent. The volume of exports was 621 million pounds (36 percent of industry total) in 1978, and exports are expected to reach 43 percent by 1990 (Chemical Week, May 7, 1980).

The primary factors behind the 1976/1977 growth from previous years are increased pesticide usage by farmers, particularly on cotton and soybeans crops, and increased foreign demand for domestic pesticides (NACA, 1978). Pesticide shipments are expected to increase by 7 percent per year, while costs are predicted to rise 6 percent per year through 1990 (Chemical Week, May 7, 1980).

The 1982 quantity of production was estimated from the production quantities (in pounds) reported for 1977 in the 308 Survey, and was adjusted to reflect changes in production levels between 1977 and 1982. Where current product-specific actual production was available it was used.

The U.S. International Trade Commission (ITC) publishes data annually on the total quantity of active ingredients produced and the average unit value (dollars per pound) for all pesticides, based on reports of manufacturers. The ITC data shows that overall production levels of pesticide active ingredients have dropped significantly between 1977 and 1982. In addition, production levels for different products have changed at different rates. Therefore, the 1977 production level of each pesticide reported in the 308 Survey was adjusted, if no actual data were available, by applying the ratio of quantity sold in 1982 to quantity produced in 1977 for the relevant product class.

This yields an estimate shown on Table IV-2 of the quantity produced in 1982 (Meta, June 1984).

Structural Grouping of Pesticides

It is useful to examine pesticides in terms of their functional groups. Similarities in molecular weight, polarity, and solubility may be found in pesticides with the same structure. These similarities may translate into similar levels and types of pollutant generated and similarities in pollutant treatability. For example, hydrolysis treatment under the proper pH and temperature conditions is effective for certain triazine compounds because they possess a similarly bound chloride ion which can be displaced by an hydroxyl ion, thereby changing the nature of the compound to a hydroxytriazine. Table IV-3 presents the 27 structural groups developed by EPA for the November 1982 proposed regulations. These groupings were also found to be a valid method of grouping pesticides for the purposes of evaluating treatability. In a detailed analyses performed by EPA (Technical Documentation of Technology Transfer for Nonconventional Pesticides, 1985,and Report to the Science Advisory Board, "Technology Transfer for the Pesticide Chemicals Industry," March 21, 1983), the 27 groups were found to be a technical basis for transferring treatability data from certain pesticide compounds to others. This analyis is described in detail in the reference, and is summarized in Section XIV and XV of this report. Further identification of chemical structure and configuration for typical and major pesticides can be found in BPT development document (EPA 440/1-78-060e). Pesticides within the scope of this study are defined by structural groups in the Glossary, Section XIX.

Geographical Location of Plants

Figure IV-1 presents the geographical location of the 119 pesticide manufacturers included in or covered by this study.

Market Value of Pesticides

The response to the 308 Survey revealed that the 1977 market value for pesticides covered by this study ranged from 2.5 to 3 billion dollars. Pesticide sales in 1978 were estimated to range from 2.2 to 3.0 billion dollars (Chemical Week, May 7, 1980).

An examination of individual plant and total industry market value ranges showed two major trends which were considered in both the technical and economic evaluation of the industry. First, as shown in Figure IV-2, almost half of the plants in 1977 produced products with an annual market value of less than 5 million dollars for all pesticides produced. This indicated that these plants must be examined closely with respect to capital expenditures required for pollution control facilities. Second, over 50 percent of the total industry market value is attributed to only 14 plants. These plants have a greater ability to finance pollution control investments as well as to maintain staffs capable of engineering, operating, and monitoring the control systems. The significance of this concentration of plants at the extremes of market value was further evaluated in terms of pollutant generation potential and technology requirements before any final conclusions were drawn concerning appropriate recommended treatment technologies and the resulting economic impact of this regulation.

The estimated market value of pesticide active ingredients sold by the manufacturers in 1982 is based on the unit values published by the International Trade Commission for subgroups (classes) which they have identified. These subgroups have correlated to the three main classes of pesticides insecticides, herbicides, and fungicides. The 1982 total market value is estimated to be $4.02 billion of which herbicides account for $1.96 billion, insecticides for $1.76 billion, and fungicides for $0.3 billion.

Level of Pesticide Production

Figure IV-3 shows that the distribution of individual pesticide production capacities is skewed toward the low end of the scale. In 1977, the Agency's data indicated 117 pesticide plants made 248 discrete pesticides from a total of 322 pesticide process sites. Of the 322 processes, more than 44 percent of the pesticides were produced at levels less than 10,000 pounds per day. This is an indication of the specialized nature and low demand for certain products. Again, it should be noted that there is a group of 14 to 18 products with high-volume, heavy-usage patterns such as some cotton insecticides or selective post-emergence herbicides. These production extremes were the reason the Agency performed individual plant evaluations of the economic impact of this regulation. Figure IV-4 shows the annual level of pesticide production for the 305 process areas with reported information. More than half the processes produce less than 1 million pounds of pesticide per year.

In 1985, 119 pesticide plants made 248 discrete pesticides from a total of 327 pesticide process areas. Current pesticide production distribution and process-specific production is similar to that demonstrated in 1977.

Number of Pesticides Produced Per Plant

Figure IV-5 demonstrates the highly individual nature of each pesticide plant and the narrow product base from which business is conducted. For example, approximately 95 percent of the plants produce no more than four pesticides, while almost 50 percent produce only one. When plants are found to produce more than one pesticide the products are usually derived from similar reaction chemistry, thereby allowing the same unit process configurations to be used with minor changes in raw materials. Although several plants are known to produce more than four pesticides during any one year, it is uncommon for plants to run more than four to five process lines simultaneously.

Number of Days Each Pesticide Produced

The frequency of pesticide production for 1977 shown in Figure IV-6 follows the same pattern as other plant operational factors. In this case, approximately 20 percent of all reported pesticides were produced less than 30 days per year, while another 20 percent were produced for all 12 months of the year. This figure indicates the seasonal nature of the majority of pesticides production, along with the few exceptions of continuous production for a group of high- to medium-volume products. Production frequency for 1985 is not available but is assumed to be similar industry-wide to that reported for 1977.

Number of Plants Producing Pesticides

Figure IV-7 demonstrates the effect of patents on the operating structure of the industry. Approximately 84 percent of all patented pesticides are only produced by individual plants, whereas after patent expiration each of the remaining 16 percent is produced at from two to four different plants. These facts contribute to the difficulty of examining and comparing wastewater data among identical products. There are several cases where the same product is made by a different process by different plants, thereby resulting in different pollutants, treatment technology required, and economic impact.

Number of Plants Owned by Companies

As demonstrated in Figure IV-8, approximately 73 percent of all companies own only one pesticide manufacturing plant. Of the remaining 27 percent, 13 companies own two plants each, four companies own four plants each, and four separate companies own three, five, six, and seven plants, respectively. The above illustrates that pesticide plant ownership is generally not concentrated among a few companies. However, it should be noted that certain companies may be the sole producer of a pesticide sub-group.

Other Operations at Pesticide Plants

Another complicating factor in obtaining and evaluating data from pesticide facilities is that very few sites produce only pesticide active ingredients. Response to the Industry 308 Survey presented in Table IV-4 shows that approximately 59 percent of the plants also produce pesticide intermediates. In addition, approximately 76 percent of the pesticide plants also produce other miscellaneous chemicals. There are only seven pesticide plants producing neither intermediates nor other chemicals, thereby representing less than 6 percent of the industry. More than 90 percent of all plants have at least one shared treatment system for pesticide process, intermediate chemicals process and miscellaneous chemicals process wastewaters. This fact highlights the closeness of this industry to this organic chemicals industry in terms of operators, wastewater characteristics, treatment methods employed, and effluent characteristics.

Methods of Wastewater Disposal

Table IV-5 itemizes the methods of wastewater disposal utilized at pesticide manufacturing plants. Many plants have more than one method of disposal, as there are a total of 148 discrete methods utilized at 119 plants. The thrust of this report is toward those plants discharging to navigable waters (45 plants), those discharging indirectly to POTWs (38 plants), and those achieving zero discharge (18 plants) because (1) no wastewater is generated (11 plants), (2) because of evaporation ponds (6 plants), or (3) because of incineration without scrubber effluent (1 plant). Plants also utilize deep well injection (18 plants), contract hauling of all wastewater (9 plants), and land disposal (5 plants). More than one means of disposal may be used by each of the 119 plants.

Type of Wastewater Treatment

Tables IV-6 and IV-7 identify the more than 30 different types of wastewater treatment technologies used.

There are 45 plants that dispose of wastewater by direct discharge to navigable waters. In-plant treatment with activated carbon, resin adsorption, hydrolysis, chemical oxidation, steam stripping, or metals separation is used by 23 direct dischargers. Further explanation of the design and operation of these treatment units is provided in Section VI. There are 28 discrete plants included in Table IV-6 that use biological treatment for direct discharge of pesticide wastewater. Biological systems may consist of an aerated lagoon, activated sludge unit, or trickling filters. Post-biological or tertiary treatment consisting of multimedia filtration or activated carbon is used by six direct dischargers. There are 38 discrete manufacturers included in Table IV-7 discharging to a municipal treatment system, of which seven plants treat pesticide wastewater by activated carbon, resin adsorption, hydrolysis, chemical oxidation, or steam stripping. More than 20 percent of the indirect dischargers do not treat at least one pesticide waste stream.

Formulator/Packagers

In formulating and packaging, the raw materials used are the pesticide active ingredients which may be procured from outside suppliers or may be manufactured on site. The processing is mechanical and physical/chemical in nature and consists of formulating, blending, canning, and packaging operations. The levels of wastewater generation and contamination are considerably lower than in the active-ingredient production, and are sometimes nonexistent. Pesticide formulations and packaged products generally fall into three classifications: water-based, solvent-based, and dry-based. Types of formulations include powders, dusts, wettable powders, emulsifiable concentrations, granules, and aerosols.

EPA proposed no discharge of process wastewater as the pretreatment standards for existing indirect discharge pesticide chemicals formulator/packagers. The Agency assumed that these indirect dischargers would conduct the same types of operations and would incur the same levels of costs as the direct dischargers for whom zero discharge BPT effluent limitations guidelines and standards were promulgated in 1979. Since proposal, EPA has acquired additional data on the formulator/packager segment of the industry. The Agency surveyed approximately 32 percent of the 3980 formulator/packagers registered under the Federal Insecticides, Fungicides, and Rodenticides Act (FIFRA). EPA randomly selected 1263 plants from the FIFRA list for initial contact through a phone survey, then followed up with questionnaires under 308 of the Clean Water Act to potential indirect dischargers and to non-respondents to the telephone survey, (see Section XX - Appendix 5). The Agency, in cooperation with representatives from industry and trade associations such as the Chemical Specialities Manufacturers Association (CSMA), National Agricultural Chemical Association (NACA), and the Pesticide Producers Association (PPA), developed the questionnaire specifically for the formulator/packager segment of the industry. This questionnaire was mailed to 221 formulator/packagers that indicated in the telephone survey that they were indirect dischargers. These questionnaires solicited information on types and volumes of wastewaters, methods and costs for disposing of these wastewaters, discharges of both nonconventional and toxic pollutants, the types of treatment in place at the facility and the viability and achievability of the zero discharge standard.

The Agency excluded formulators/packagers which produced sanitizers, disinfectants, inorganics or surface active agents from the 308 survey. Subsequently, the Agency also deleted plants which only formulate and package pesticide active ingredients for which there are no proposed or promulgated analytical methods. The results of the sample were extrapolated to the total universe of 3980 plants on the FIFRA list. Based on public comments and follow-up contacts the Agency corrected and adjusted the collected data. The process for acquiring the data and for making corrections is described in the report "Evaluation Of Regulatory Options And The Development Of PSES and NSPS Compliance Costs For The Pesticide Formulating And Packaging Industry", which is in the public record. Through this procedure, the Agency determined that there are approximately 1264 PFP plants of which about 169 discharge indirectly and about 1095 do not discharge. The remaining 2716 plants are either closed, foreign, duplicates or are not pesticide formulator/packagers.

The scale on which pesticides are formulated covers a broad range. Many of the small firms have only one product registration, and produce only a few hundred pounds of formulated pesticides each year. However one plant operating in the range of 100,000,000 pounds of formulated product per year has been identified.

Pesticide formulating and packaging product market value averages $8.21 million per plant for low flow plants and $55.5 million per plant for high flow plants. Production frequency averages 28 weeks annually per plant with only a few plants operating 52 weeks annually.

At formulating and packaging plants, contaminated wastestreams are a small percent of the total wastes which are generated.

Zero discharge of process wastewater pollutants is being achieved by 87 percent of all pesticide formulating and packaging plants. Contract hauling has been costed as a no discharge technology at low flow plants, whereas wastewater treatment and reuse appears to be a less costly means of achieving no discharge at high flow plants. For a more detailed discussion of the PFP study see Evaluation of Regulatory Options and the Development of PSES and NSPS compliance costs for the Pesticide Formulating and Packaging Industry, August 30, 1985.

Metallo-Organic Pesticide Manufacturers

Metallo-organic pesticides include all compounds with metallic bases of arsenic, cadmium, copper and mercury. In the manufacturing process for metallo-organic pesticides, the principal sources of wastewater are: byproduct stripping, product washing, caustic scrubbing, tank and reactor clean-out, and area washdowns.

The promulgated BPT regulation for this group of pesticides requires zero discharge of process wastewater pollutants. All manufacturing sites achieved zero discharge. However, EPA has subsequently identified one manufacturer producing mercury-based metallo-organic compounds that has a discharge to a POTW. After evaluating the data from this plant, the Agency has concluded that treatment of the process wastewater followed by discharge at this one facility is an environmentally acceptable alternative to incineration or contract hauling, the BPT recommended technology. This issue is discussed in detail in Sections VI, VII, XII, and XV.

Table IV-1. Pesticide Production by Class (1977)

Class	Number of Products	Production Volume (1977) Million lbs	Percent
Insecticide*	108	846	51.74
Herbicide	86	554	33.88
Fungicide+	60	229**	14.01**
Fungicide/Bactericide	15	NA	NA
Rodenticide	9	2	0.12
Plant Growth Regulator	1	4	0.25
Protectant	1	NA	NA
TOTAL	280	1,635	100

* Includes miticides, nematicides, repellants, insect synergists, fumigants, insect growth regulators, insecticides.

+ Includes algicides and molluscicides.

** Include both fungicides and fungicide/bactericides.

++ Production not available from 30 (9.3 percent) of 322 process sites.

NA Not available

Table IV-2. Estimated Pesticide Production by Class (1982)

Class	Number of Products	Estimated Production Volume (1982)	
		Million lbs	Percent
Insecticide*	108	621	49.40
Herbicide	86	476	37.87
Fungicide+	60	155**	12.33**
Fungicide/Bactericide	15		
Rodenticide	9	2	0.16
Plant Growth Regulator	1	3	0.24
Protectant	1	NA	NA
TOTAL	280	1,257++	100

* Includes miticides, nematicides, repellants, insect synergists, fumigants, insect growth regulators, insecticides.

+ Includes algicides, bactericides, mulluscicides.

** Includes both fungicides and fungicide/bactericides

++ Production not available from 35 (10.7 percent) of 327 process sites.

NA Not available

Table IV-3. Structural Grouping of Pesticides

Structural Grouping of Pesticides	Number of Pesticides in Group
Aldrin-Toxaphene	7
Amides	9
Amide type	4
Botanicals	5
Carbamates	15
Chlorinated Aryloxyalkanoic Acids and Esters	15
Cyanates	3
DDT type	7
Dioxin type	1
Halogenated Aliphatics	10
Halogenated Aromatics	23
Heterocyclic with Nitrogen in the Ring	20
Metallo-Organic*	14
Nitro	13
Nonhalogenated aliphatics	1
Nonhalogenated aromatics	8
Nonhalogenated Cyclic Aliphatics	1
Organo Nitrogen-Others	17
Organo Sulfur	5
Phosphates and Phosphonates	5
Phosphorothioates and Phosphorodithioates	36
Phosphorus-Nitrogen	6
Thiocarbamates	14
Triazines	14
Uracils	2
Ureas	11
Noncategorized Pesticides	14
TOTAL	**279**

* Does not include mercury, copper, cadmium, and arsenic-based products.

Table IV-4. Types of Operations at Pesticide Plants (1985)

Type of Operation	Number of Plants	Percent of Total
Manufacturer of Pesticide Active Ingredients	119	100
Manufacturer of Other Miscellaneous Chemicals	90	75.6
Manufacturer of Pesticide Intermediates	70	58.8
Formulator/Packager of Pesticides	57	47.9

Table IV-5. Methods of Wastewater Disposal at Pesticide Plants (1985)

Type of Wastewater Disposal	Number of Plants*
Direct Discharge to Navigable Waters	45
Indirect Discharge (POTW, etc.)	38
Deep Well Injection	18
Incineration	15
No Wastewater Generated	11
Contract Hauling of all Wastewater	9
Evaporation Ponds	6
Land Disposal	5
Not Available	2

* There are a total of 119 plants in the industry; however, many have more than one means of disposal.

Includes wastewater which is recycled, reused, or because no wastewater is generated.

Table IV-6. Treatment Utilized at Plants Disposing Pesticide Wastewaters to Navigable Waters

Type of Wastewater Treatment	Number of Plants*
Activated Carbon	17+
Activated Sludge	17
Aerated Lagoon	17
Aerobic Digestion	2
Anaerobic Digestor	1
API-Type Separator	1
Chemical Oxidation	7
Coagulation	5
Cyanide Detoxification	1
Equalization	32
Evaporation Pond	2
Flocculation	4
Gravity Separation	28
Hydrolysis	6
Liquid-liquid Extraction	1
Metal Separation	2
Multimedia Filtration	7**
Neutralization	31
None	2
Nutrient Addition	1
Pressure Leaf Filter	2
Resin Adsorption	2
Skimming	8
Sludge Thickening	1
Solvent Extraction	1
Stripping	4
Trickling Filters	3
Vacuum Filtration	1
Wet Scrubber	5

* There are a total of 45 plants disposing to navigable waters; some use more than one type of wastewater treatment.

+ Activated carbon used as tertiary treatment in five waste streams.

** Multimedia filtration used as tertiary treatment in two waste streams.

Table IV-7. Treatment Utilized at Plants Disposing Pesticide Wastewaters to POTWs

Type of Wastewater Treatment	Number of Plants*
Activated Carbon	2
Activated Sludge	3
Aerated Lagoon	2
Chemical Oxidation	1
Coagulation	2
Crystallization	1
Equalization	11
Evaporation Pond	1
Flocculation	2
Gravity Separation	14
Hydrolysis	1
Multieffect Evaporation	1
Multimedia Filtration	2
Neutralization	24
None	8
Not Available	1
Resin Adsorption	2
Skimming	6
Sludge Thickening	1
Stripping	3
Vacuum Filtration	2
Wet Scrubber	1

* There are a total of 38 plants disposing to POTWs; some use more than one type of wastewater treatment.

Table IV-8. Formulator/Packager Production Distribution

Production (million lbs/yr)	Percent Formulator/Packagers
<0.5	24
>0.5 to <5.0	41
>5.0 to <50	35
TOTAL	100

Table IV-9. Percent of Formulator/Packager Pesticide Classes

Class	Percentage
Herbicides	40.0
Insecticides	32.0
Fungicides	19.4
Fumigants	8.6
TOTAL	100

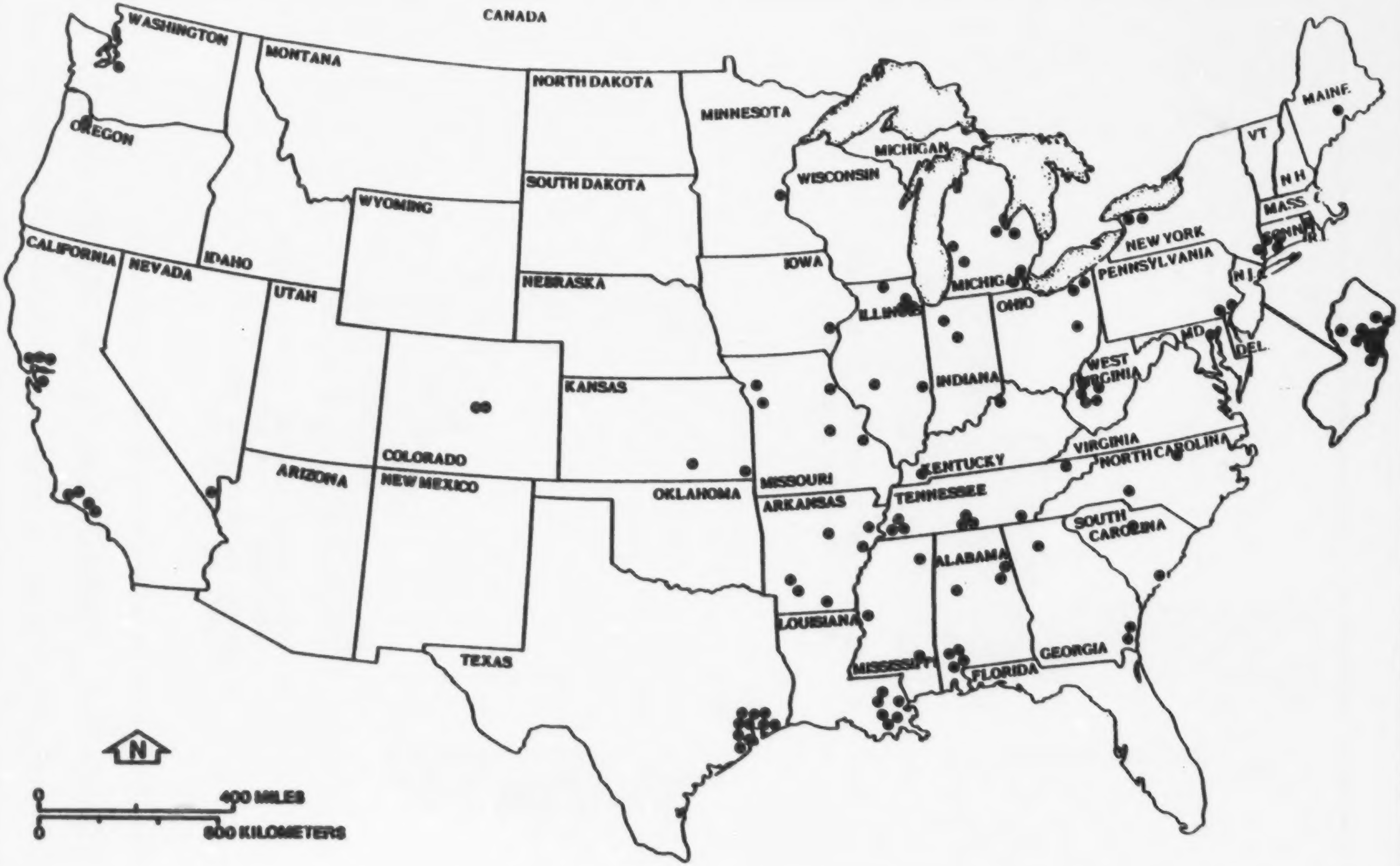
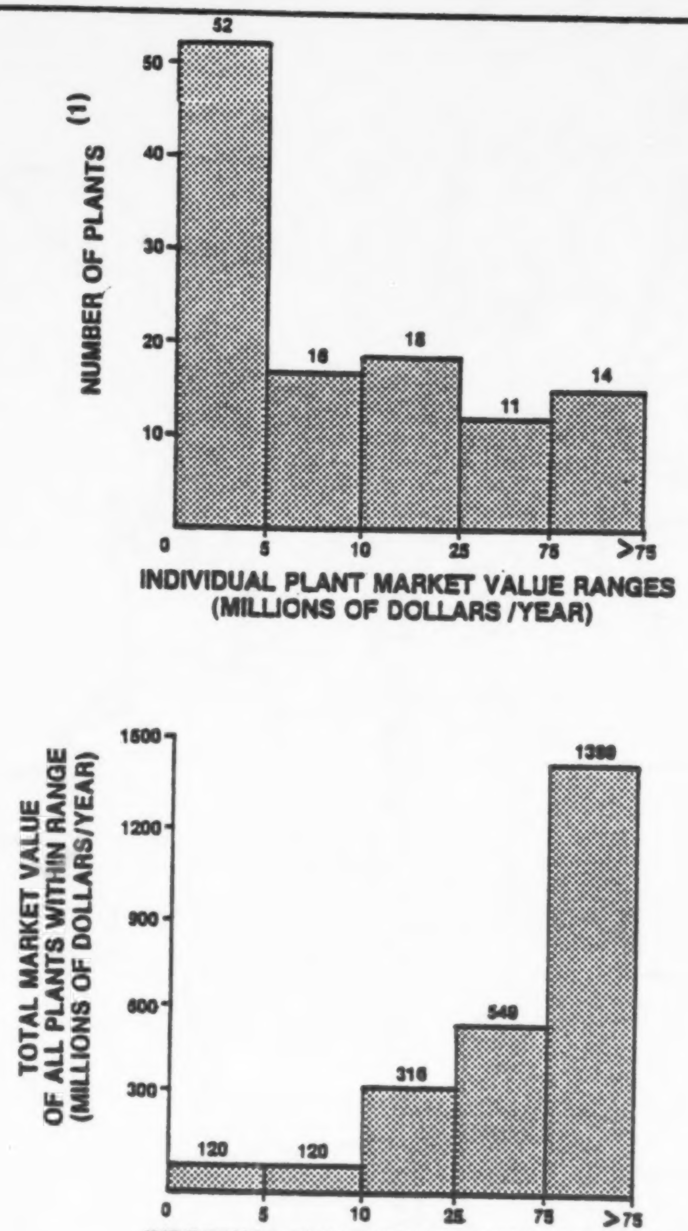
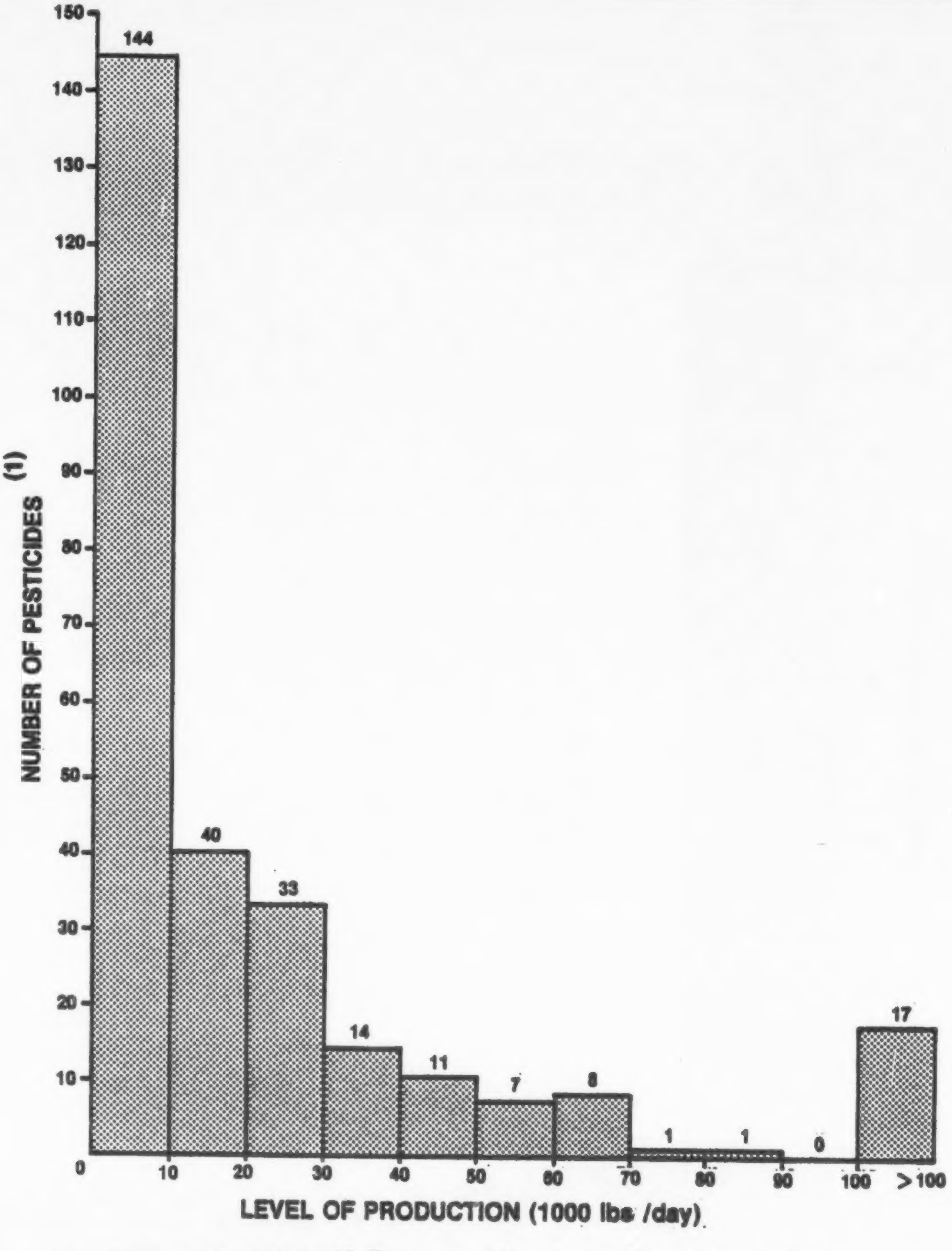


Figure IV Geographical Location of Pesticide Chemicals Manufacturers (Total of 119 Plants)



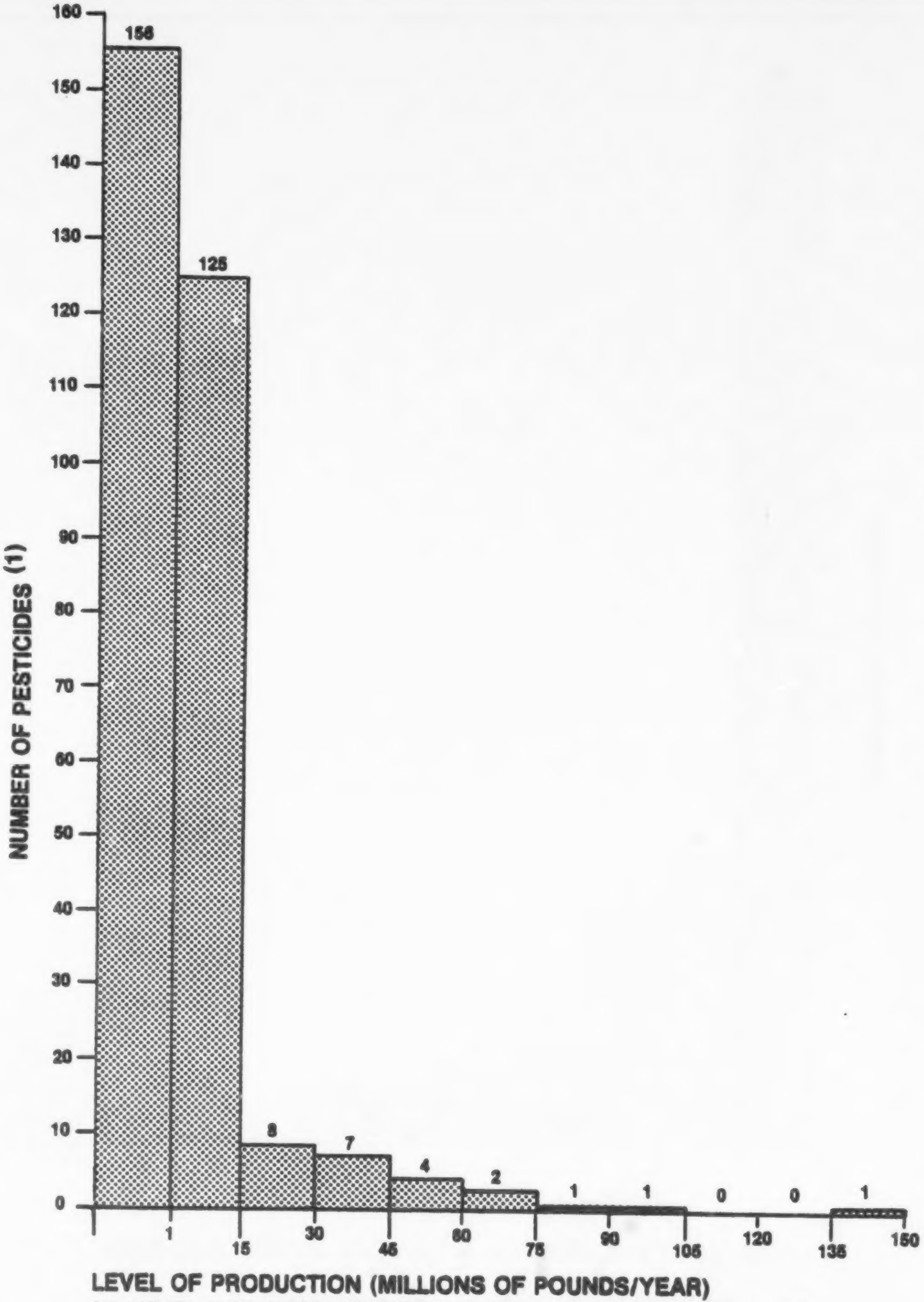
(1) MARKET VALUE RANGES FOR 6 OF 117 PLANTS NOT AVAILABLE

FIGURE IV-2. MARKET VALUE OF PESTICIDES (1977)



(1) LEVEL NOT AVAILABLE FOR 45 (14%) OF 322 PROCESS SITES

FIGURE IV-3 DAILY LEVEL OF PESTICIDE PRODUCTION (1977)



(1) LEVEL NOT AVAILABLE FOR 17 (5%) OF 322 PROCESS SITES

Figure IV-4 ANNUAL LEVEL OF PESTICIDE PRODUCTION (1977)

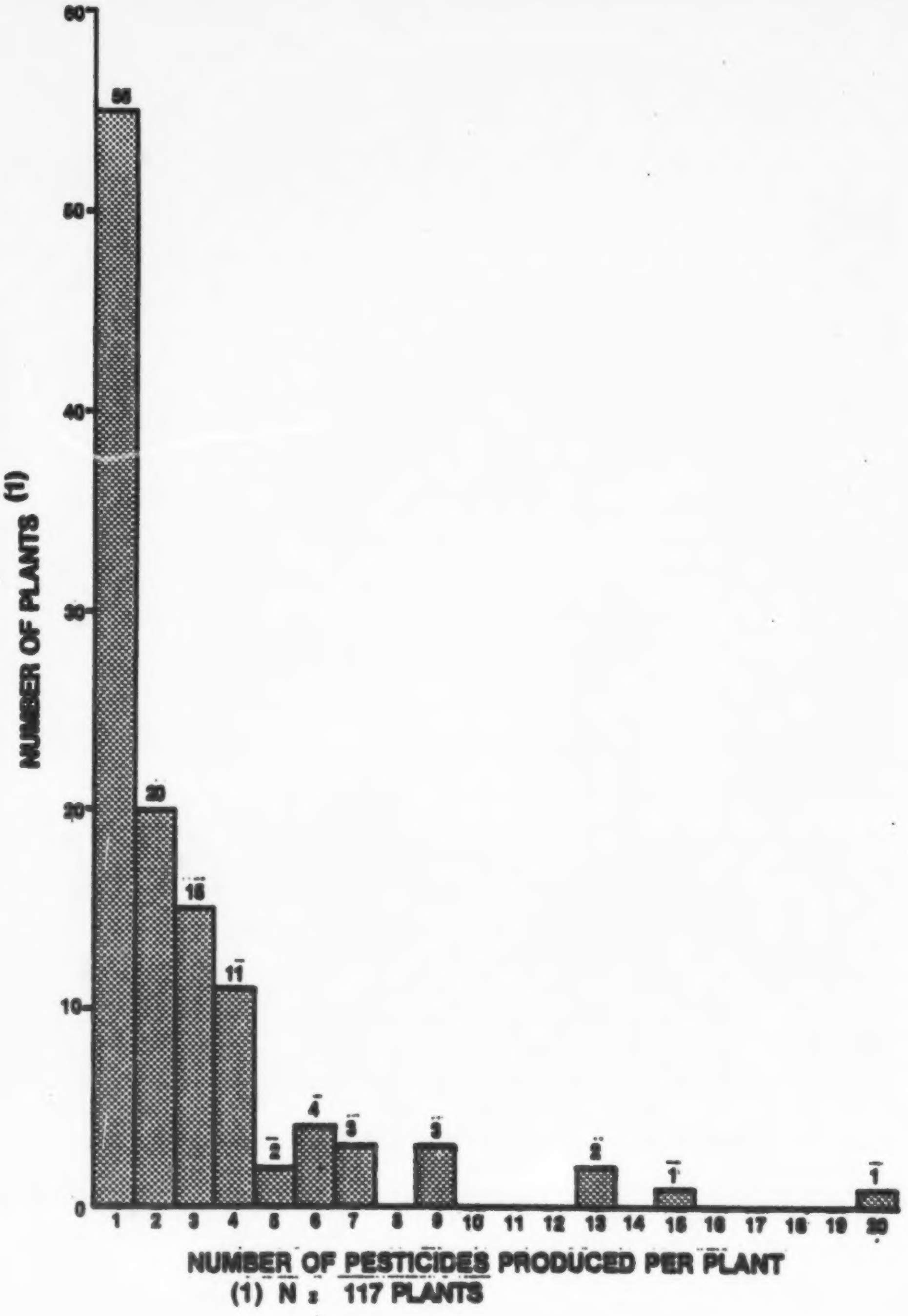
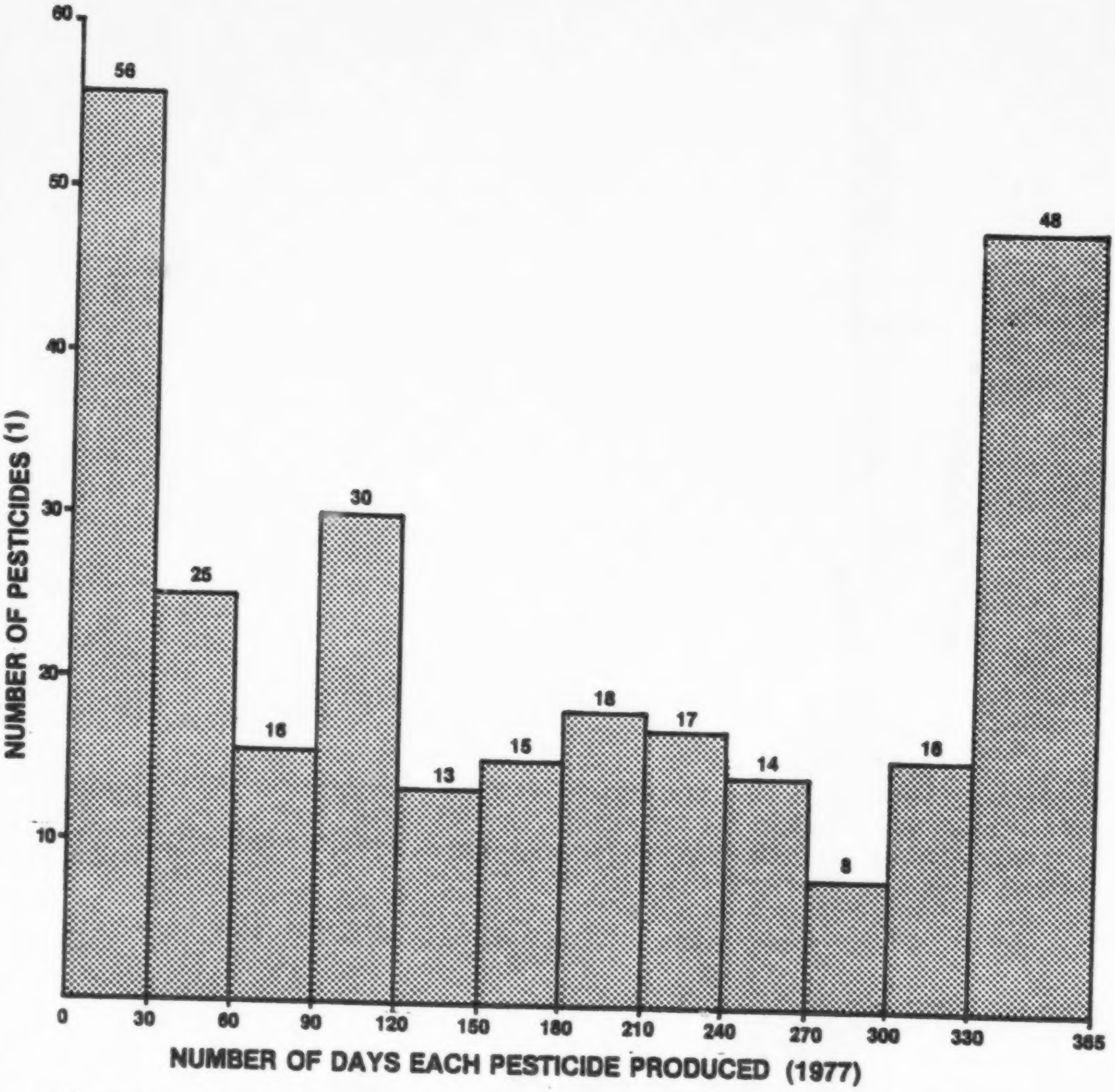


FIGURE IV-5 NUMBER OF PESTICIDES PRODUCED PER PLANT (1977)



(1) FREQUENCY NOT AVAILABLE FOR 46 (14.3%) OF 322 PROCESS SITES

FIGURE IV-6 FREQUENCY OF PESTICIDE PRODUCTION (1977)

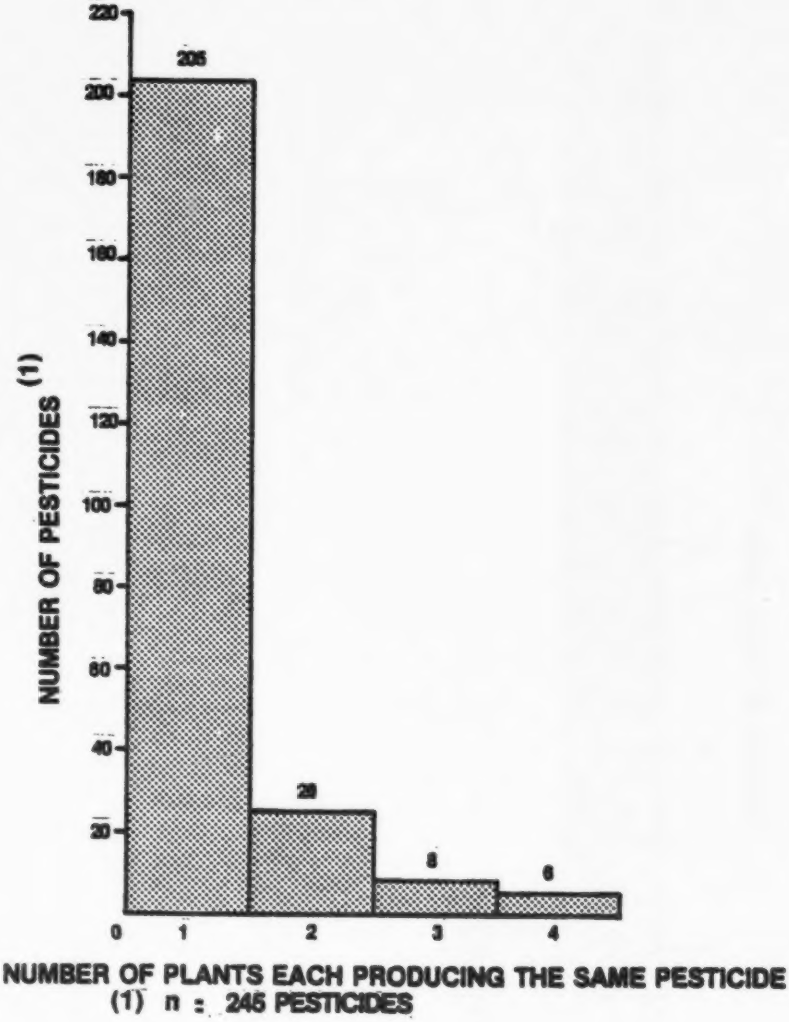


FIGURE IV-7 NUMBER OF PLANTS EACH PRODUCING THE SAME PESTICIDE (1977)

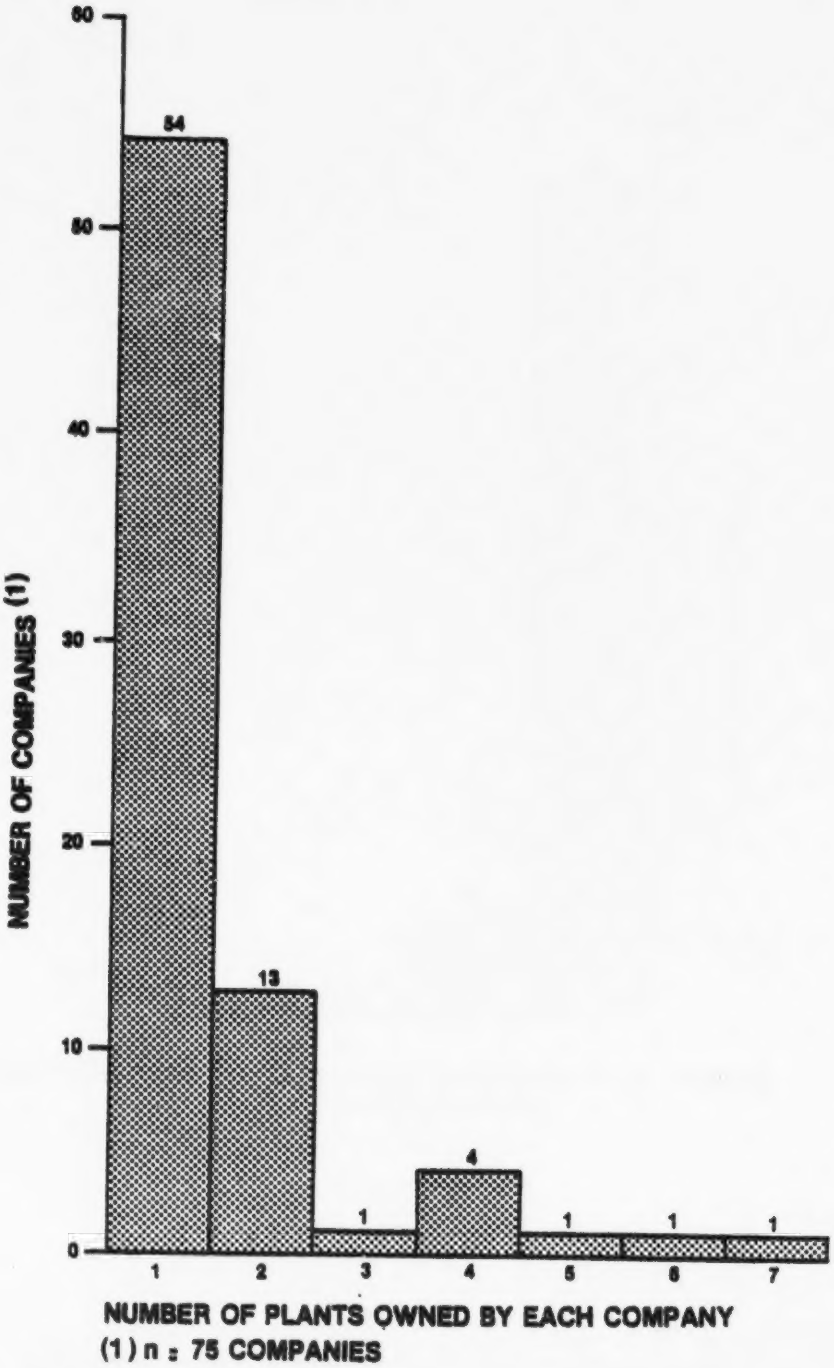


Figure IV-8 NUMBER OF PLANTS OWNED BY EACH COMPANY (1977)

SECTION V

RAW WASTE LOAD CHARACTERIZATION

ORGANIC PESTICIDES CHEMICALS MANUFACTURING SUBCATEGORY

The purpose of this section is to present information on the raw waste load and process wastewater characteristics for the 280 pesticides covered under the organic pesticide manufacturers portion of this study in terms of the priority pollutants, conventional, and nonconventional parameters originating from these processes. The term "raw waste load," as utilized in this document, is defined as the quantity of pollutant in wastewater prior to a treatment process. The flow of the raw waste is normally expressed in terms of million gallons per day (MGD), or gallons of wastewater per 1,000 pounds of pesticide production (gal/1,000 lbs). Raw waste load characteristics are normally expressed in milligrams per liter (mg/l) or pounds of pollutant per 1,000 pounds of pesticide production (lbs/1,000 lbs).

In order to assess the pollutant potential for the organic pesticide chemical manufacturing industry as a whole, it was necessary to approach the task from two directions: first, all available raw waste load data were collected from the BPT study, from pesticide manufacturers' responses to the 308 Survey and subsequent follow-up letters, from screening sampling, from the verification sampling program conducted at 16 pesticide plants, and public comment responses to the November 1982 proposal, June 13, 1984 NOA and January 24, 1985 NOA. Second, a process chemistry evaluation of each pesticide was conducted in order to determine which pollutants were likely to be present. Data presented within this section are typical raw waste loads gathered from BPT through BAT proposal. Data subsequent to BAT proposal have been thoroughly reviewed and evaluated with the results included in subsequent sections of this document but are not included in this section since the new information reaffirms the Agency's previous conclusions on raw waste loads.

The flow, concentration and mass per unit of production were calculated for each pollutant at each plant where data were available. Pollutant concentration data was evaluated according to groups of priority pollutants which are similar in chemical/physical characteristics and which are measured by similar chemical analytical methods. Section XIX--Glossary, and Section XX-Appendix 1, provides identification of specific compounds within each priority pollutant group which are included in the scope of this study.

Priority pollutants likely to be present were determined by conducting a process chemistry evaluation for each pesticide process. The possible sources of the pollutants were identified as: the manufactured product itself, raw materials used in pesticide synthesis, impurities in either the product or raw materials, byproducts of synthesis reactions, solvents used as a carrier medium, solvents used as an extraction medium, impurities in solvents, catalysts, and impurities in the catalysts.

The Agency conducted these evaluations by examining propietary process chemistry diagrams supplied by manufacturers. These proprietary diagrams are the bases for some of the process chemistry evaluations. Supplemental literature was also used which includes Considine (1974), Entomological Society of America (1974), Kirk and Othmer (2nd Ed.), Sittig (1980), SRI International (1979), Ware (1978), Weast (1974) and Worthing (1979). Process conditions such as pH, temperature, pressure, and reaction time were considered in the evaluations.

The Agency proposed these evaluations in November 1982. In response to public comment, some modifications were considered as set forth in the June 13, 1984 NOA. In response to the public comment on the NOA additional modifications were made. The process chemistry evaluation for the final regulation was done in the following manner.

1. An abbreviated process description was developed for all of the pesticide products listed. In some cases, synthetic routes to the raw materials were also developed. These process descriptions were developed and/or checked for applicability to specific plants by reference to five sources:

   a. "Pesticide Manufacturing and Toxic Materials Control Encyclopedia" by Sittig. This book is based on the patent literature and other publicly available sources.

   b. "The Pesticide Manual" by the British Crop Protection Council. This book is based on the patent literature and other publicly available sources.

   c. A 5-volume confidential review of pesticide manufacturing processes prepared by an EPA contractor and used to develop the list in Section XX-Appendix 6. The confidential 5-volume series incorporated comments submitted on the proposal concerning the priority pollutants regulated as a result of our process chemistry evaluation. If there were questions about the process review, sources (d) and (c) were also utilized.

d. Process flow diagrams and other information in the 308 questionnaire submitted by the plant(s) that manufactured a particular pesticide product.

e. Direct phone contact with plant (or corporate) environmental staff that submitted the 308 questionnaire, or by their referral to a plant process chemist that was qualified to answer specific questions about the process descriptions given in the 308 questionnaire.

2. The priority pollutants listed for each pesticide product were examined for consistency with the process descriptions developed in Step 1. For each pesticide product, priority pollutants were retained, added or deleted to make the associated priority pollutants consistent with the chemistry of the respective processes.

3. When the associated priority pollutants contained more than one member of a generic group (e.g., chlorophenols), the predominant member of the group was listed for control, and the other members were deleted. This listing criterion was based on the fact that treatment to control the member present at the highest concentration would also control the other members that are present at lower concentrations. Predominance was determined principally by whether the pollutant was a raw material, solvent, product or byproduct in the process. If one member was a raw material and another member was a solvent, both would be considered predominate and acccordingly listed. If none of these process ingredients was a priority pollutant, then listing was determined by whether the pollutant was a likely impurity in the process ingredients.

Exceptions to the listing criterion were:

a. If members of the group were not amenable to the same or similar control technology, they were not deleted. For a discussion of the treatability of pollutants by the same or similiar treatment technology see chapter VI of the Development Document. In this case, members not treatable to the same control technology were listed separately (e.g., chlorophenol vs. pentachlorophenol).

b. If all members of the group occur only as impurities in the process ingredients, then all were retained in the listing. In this case, there is no obvious means of establishing predominance.

4. Once an independent process chemistry evaluation had been performed pursuant to steps 1-3, an evaluation was made of the NOA comments concerning the priority pollutants regulated as a result of our process chemistry evaluation. If commenters recommended that a priority pollutant be either added or deleted and their rationale was not obvious given steps 1-3, as described above, the Agency reviewed the appropriate 308 data and/or telephoned the commenter to determine whether or not the priority pollutant was associated with the manufacturing process. If as a result of these steps a revision was considered appropriate, it was made.

The indicated and detected presence of pollutants derived in this manner is presented in Tables V-1 through V-30. These typical data are also utilized in later sections of this report to provide a basis for design and costing of recommended treatment systems and to provide a basis for the selection of priority pollutant parameters to be regulated.

FLOW

The process wastewater flow for each pesticide was evaluated to determine the amount of flow per unit of pesticide production (gal/1,000 lbs) and the amount of flow (MGD) from all pesticides produced at individual plants.

Figure V-1 presents a probability plot of the flow ratio (gal/1,000 lbs) for 269 of the 327 pesticide process areas for which data were available. Significant information in this figure shows that: 11 percent of all pesticide processes have no flow; 50 percent of all pesticide processes have flows equal to or less than 1,000 gal/1,000 lbs; and 84 percent (approximately one standard deviation above the median) have flows equal to or less than 4,500 gal/1,000 lbs.

Figure V-2 presents a probability plot of pesticide flows (MGD) at individual plants. This figure shows that 50 percent of all plants have flows less than 0.01 MGD, and that virtually all plants (98 percent) have flows less than 1.0 MGD. In Section VIII of this report treatment cost estimates are based on the range of flows from 0.01 to 1.0 MGD.

Flows reported in the tables presented later in this section represent the flow measured at the given sample point which generally does not represent either the pesticide process flow or total plant flow (see tables listing pollutants detected in pesticide process wastewaters).

PRIORITY POLLUTANTS

An overview of the detected/indicated frequency of priority pollutant groups is presented in Table V-1. These data show that even the most prevalent pollutant group, volatile aromatics, is indicated to be present in only approximately 42 percent of the 280 pesticides in the scope of study. A specific discussion of the significance of each priority pollutant in relation to this industry is provided in Section IX. An evaluation was conducted of the frequency of occurrence of priority pollutants in pesticide process wastewaters, based on 308 questionnaire data and verification sampling data. The following results reflect a review of proposal and notice comments submitted by industry and others as well as a re-evaluation of pre-existing information on the frequency of occurrence of priority pollutants in pesticides process wastewaters presented in the proposal. Any data that was provided was reviewed for technical quality and analytical acceptability and incorporated into the process chemistry review. Quality assurance/quality control guidelines used in their review are discussed in Section III.

Priority pollutants which were detected in pesticide wastewaters or indicated to be present based on the process chemistry evaluation were identified for each nonconventional pesticide manufacturing process regardless of the regulatory status of the active ingredient.

Due to the variety and uniqueness of the pesticide manufacturing processes, some general assumptions were used to determine relative concentrations between pollutant types such as raw materials and solvents, and byproducts and impurities. Sufficient information, such as kinetic measurements for all reactions, was not available to determine rates of pollutant formation. However, general assumptions regarding relative quantitation were made based on knowledge of generalized chemical reactions, physical processes, reaction sequence, reaction completion, and unreacted feedstocks typical of all pesticide processes. These general assumptions were verified by an inspection of standard handbooks of chemistry, by evaluation of 308 questionnaires, and by follow-up plant contacts. The following general assumptions, upon which some specific assumptions depend, have been implicitly used.

1. All chemical feedstocks are of less than 100 percent purity. The contaminates of feedstocks may be classified as impurities or reaction byproducts. The impurities that may be present in feedstocks are considered to be the raw materials, solvents, catalysts, and other compounds used in feedstock synthesis. In regard to chemical feedstocks,

reaction byproducts are secondary compounds formed in feedstock synthesis. The process for producing a chemical feedstock is based on information from Merck Index (1976) unless otherwise noted. Although not always true, this process is assumed to be the actual industrial chemical synthetic route employed by the supplier to the pesticide plants.

2. A suspected impurity is assumed to be inert with regard to the chemical reactions of pesticide synthesis.

3. Unless information was available to the contrary, impurities in a raw material, solvent, or catalyst used in a pesticide process are not suspected as wastewater constituents in significant quantities.

4. Chemical feedstock reaction byproducts are assumed to be present in negligible quantities and are therefore not expected to be present in a wastewater produced from a pesticide synthesis using that chemical feedstock (see assumption 1 above). Hexachlorobutadiene, HCBD, is an exception to this assumption. HCBD is a byproduct of the hexachlorocyclopentadiene, HCCPD, synthesis reaction, but it is known to exist in high concentrations in the raw material.

5. Reaction byproducts are any compounds other than the final product that are formed during pesticide synthesis. They may result from either the main synthesis reactions or the side reactions described as byproduct reactions. These byproducts of main synthesis reactions are sometimes referred to as co-products.

6. If members of a priority pollutant group are expected to be present in a process wastestream, then only the pollutant likely to be most prevalent was selected as the effluent limited priority pollutant for a priority pollutant group, because technology used to control the most prevalent member adequately controls the other group members.

7. If the chemical of concern in a process wastestream is not a priority pollutant, but is typically associated with low levels of priority pollutants, then the associated priority pollutants would be considered.

These general assumptions provided support for the qualitative specific assumptions found in each pollutant group subsection. Specific groups of pollutants were identified for the Pesticide

Industry. Fourteen priority pollutant groups are addressed in this report. Arranged in alphabetical order by group, confidential Tables 1 through 14 found in the confidential addendum to this document list the priority pollutants indicated to be present in pesticide process wastewaters. These tables also depict the pollutant source for each pesticide as raw material, solvent, catalyst, impurity, or byproduct. Much of the information presented in these tables has been submitted in response to Agency's request for information. Information requested pursuant to Section 308 may not be withheld from the Agency on the ground that it is considered confidential or proprietary. Section 308(b), however, does accord protection to trade secrets. As such, some of the information relating to production processes and materials has been claimed as confidential and pesticide names and plant names are coded where appropriate throughout this document.

Section XX-Appendix 6 presents a listing of the indicated priority pollutants for each nonconventional pesticide. It was determined that for 12 pesticides produced at more than one plant, the priority pollutants indicated to be present differed from plant to plant based on the manufacturing process at each plant. The priority pollutants listed for these pesticides are specified by plant in Appendix 6. The list of priority pollutants indicated to be present was evaluated by pollutant group to identify the pollutants of primary significance for regulation. This evaluation paralleled that which was conducted for proposal and presented in the Proposed Development Document.

A discussion of the process chemistry evaluation employed to predict the priority pollutants in pesticide wastewaters is presented by group as follows in order of prevalence in the industry.

Volatile Aromatics

Benzene and its derivatives are used widely throughout the chemical industry as solvents and raw materials. Table V-2 contains a coded list of the suspected presence of these compounds in the pesticide industry. Table V-3 list historical data typically detected in pesticide process wastewaters for volitile aromatics.

Mono-, di-, and trichlorobenzenes are used directly as pesticides for their insecticidal and fungicidal properties. Benzene, toluene, and chlorobenzene are used as raw materials in the synthesis of at least 15 pesticides, although their main use is as a carrier solvent in 76 processes. It is predicted that additional priority pollutant aromatics and chlorinated aromatics exist as impurities or reaction byproducts due to the reactions of the basic raw material and solvent compounds.

Process descriptions were developed for all the pesticide products listed. These process descriptions were developed and/or checked for applicability to specific plants by reference to the five sources mentioned earlier in this section. The volatile aromatic listed for each pesticide product was examined for consistency with process descriptions reviewed. Assumptions were then drawn from this examination to provide a basis for developing the list of volatile aromatics suspected in pesticide waste streams. The assumptions are as follows:

1. When xylene is used as a solvent in the process, then impurities such as benzene, toluene, and ethylbenzene are suspected to be present.

2. When trichlorodiphenylethane in a benzene solution is used as a raw material, then benzene is suspected to be present as a raw material impurity.

3. When toluene sulfonic acid is used as a raw material, then toluene is suspected to be present as a raw material impurity.

4. When parachlorobenzotrifluoride is used as a raw material, then chlorobenzene is suspected to be present as a raw material impurity.

5. When 1,1,1-trichloro - 2,2-diphenyl ethane is used as a raw material, then benzene is suspected to be present as a raw material impurity.

6. When tetrachlorobenzene is used as a raw material, then 1,2,4-trichlorobenzene is suspected to be present as a raw material impurity. Hexachlorobenzene was also identified by the pesticide manufacturer as a byproduct in the PCNB process.

7. When producing the pesticide DCPA, hexachlorobenzene was identified by the manufacturer as a byproduct during the esterification reaction.

8. When bis-chloromethyldodecyltoluene is used as a raw material, then toluene is suspected to be present as a raw material impurity.

9. When DDT is used as a raw material, then chlorobenzene is suspected to be present as a raw material impurity.

10. When p-toluene sulfonic acid is used as a catalyst, then toluene is suspected to be present as an impurity in the catalyst.

11. During the chlorination of benzene, byproducts such as chlorobenzene is suspected to be present.

12. 1,4-dichlrobenzene is suspected as a byproduct in the formation of 1,2-dichlorobenzene, and 1-2-dichlorobenzene is suspected as a byproduct in the 1,4-dichlorobenzene formation.

13. When 2,2,2',4',5'-pentachloroacetophenone is used as a raw material, then 1,2,4-trichlorobenzene is suspected to be present as an impurity in the raw material.

14. When producing the pesticide toxaphene, chlorobenzene was identified by the manufacturer to be present in the process; however, the reaction source has not been determined.

15. When 4-chlorothiophenol is used as a raw material, then benzene and chlorobenzene are suspected to be impurities in the raw material.

16. During the production of thiabendazole, 1,3-dichlorobenzene was identified by the manufacturer to be present in the process; however, the reaction source has not been determined.

17. When dichlorophen is used as a raw material, then toluene is suspected to be present as a raw material impurity.

18. When 2,4-dichlorobenzophenone is used as a raw material, then chlorobenzene is suspected to be present as a raw material impurity.

Halomethanes

Table V-4 shows that methylene chloride, chloroform, and carbon tetrachloride (di-, tri-, and tetra-chloromethane, respectively) are used mainly as raw materials and solvents in approximately 28 pesticide processes. Table V-5 list historical data typically detected in pesticide process wastewaters for halomethanes. Bromomethanes can be expected in at least five pesticides as raw materials, byproducts, or impurities and can function as a fumigant, in the case of methyl bromide. The fluoromethanes are used as aerosol propellants, but they are not expected in pesticide process wastewaters.

Process descriptions were developed for all the pesticide products listed. These process descriptions were developed and/or checked for applicability to specific plants by reference to the five sources mentioned earlier in this section. The halemethane listed for each pesticide product was examined for consistency with process descriptions reviewed. Assumptions were than drawn from this examination of provide a basis for developing the list of halomethanes suspected in pesticide waste streams. The assumptions are as follows:

1. Methanol in the presence of hydrogen chloride will react to form methyl chloride.

2. When trimethyl phosphite is reacted with chloral, methyl chloroacetoacetate, methyl crotonamide, or pentachloroacetophenone then methyl chloride is suspected to be present as a reaction byproduct and is vented as a gas and either incinerated or recovered. Methyl chloride is suspected to be presented in the incinerator scrubber or recovery system aqueous effluent.

3. When methylene bromide is used as a raw material, then methyl bromide, bromoform, and methylene chloride are suspected to be present as impurities in the raw material.

4. When producing the pesticide ethylene dibromide, bromoform was identified by the manufacturer; however, the reaction source has not been determined.

5. When coke, oxygen, and carbon dioxide are reacted to form carbon monoxide, then methane is suspected as aD@ byproduct. Upon chlorina phosgene, methane is also chlorinated and methyl chloride, methylene chloride, chloroform, and carbon tetrachloride are suspected to be present as reaction byproducts.

6. When cyanuric chloride is used as a raw material, then carbon tetrachloride is suspected to be present as a raw material impurity.

7. When trichloromethane sulfenyl chloride is used as a raw material, then chloroform is suspected to be present as an impurity in the raw material.

8. When 2,4-DB is used as a raw material, then methylene chloride is suspected to be present as an impurity in the raw material.

9. When chlorobenzene is used as a phosgenation solvent then carbon tetrachloride is suspected to be present as an impurity.

10. When producing certain pesticides, methylene chloride is used as a purification solvent.

Cyanide

Cyanide is a known or suspected pollutant in approximately 24 pesticide processes, as shown in Table V-6. Table V-7 lists typical cyanide data detected in pesticide wastewaters. The primary raw materials which favor the generation of cyanides as either byproducts or impurities are cyanamides, cyanates, thiocyanates, and cyanuric chloride. Cyanuric chloride is used exclusively in the manufacture of triazine pesticides.

Process descriptions were developed for all the pesticide products listed. These process descriptions were developed and/or checked for applicability to specific plants by reference to the five sources mentioned earlier in this section. If cyanide was listed for a pesticide product its listing was examined for consistency with process descriptions reviewed. Assumptions were then drawn from this examination to provide a basis for developing the list of cases where cyanide compounds are suspected in pesticide waste streams. The assumptions are as follows:

1. When cyanuric chloride is used as a raw material, then cyanide is suspected to be present as a reaction byproduct from the degradation product cyanogen chloride as well as a raw material impurity.

2. When methyl cyanocarbamate, isophthalodinitrile, cyanamide, sodium cyanate, sodium thiocyanate, 2-cyanopyridine, ammonium thiocyanate, cyanamide 50, or thiazole is used as a raw material in the pesticide process, then cyanide is suspected to be present only as an impurity introduced during the synthesis of these raw materials.

3. When sodium cyanate is used as a raw material then cyanide is suspected to be present in the wastewater.

4. When aminoisobutyronitrile is used as a raw material, then cyanide is suspected to be present as a raw material impurity.

5. When sodium cyanide is used as a starting material in producing dichlorobenzin then cyanide is suspected to be present as an impurity in dichlorobenzil.

6. When azobisisobutyronitrile is used as a catalyst then cyanide is suspected to be present as an impurity in the catalyst.

7. When pesticides that use cyanuric chloride as a raw material are used as a feed stock, then cyanide is suspected to be present as a raw material impurity and reaction byproduct.

Haloethers

There are five compounds classified as priority pollutants that contain an ether moiety and halogen atoms attached to the aryl and alkyl groups. Table V-8 identified five pesticides suspected to contain at least one compound from this class. Bis(2-chloroethyl)ether (BCEE) is used as a raw material in two pesticides, while BCEE itself, di(chloroethyl)ether, functions as a fungicide or bactericide in certain applications. In the remainder of the pesticides the ethers are shown to be suspected raw material impurities. Table V-9 list historical data typically detected in pesticide process wastewaters.

Process descriptions were developed for all the pesticide products listed. These process descriptions were developed and/or checked for applicability to specific plants by reference to the five sources mentioned earlier in this section. The haloether compound listed for each pesticide product was examined for consistency with process descriptions reviwed. An assumption was then drawn from this examination to provide a basis for suspecting that BCEE is present in pesticide waste streams. The assumption is as follows:

1. When butyl carbitol or butyl carbitol chloride is used as a raw material, then BCEE is suspected to be present as a raw material impurity.

Phenols

Phenols are compounds having the hydroxyl (OH) group attached directly to an aromatic ring. The phenolic compounds under consideration in this study are derivatives of phenol, in particular chlorophenols, nitrophenols, and methylphenols (cresols). Table V-10 contains a coded list of the suspected presence of the compounds in the pesticide industry. Table V-11 lists historical data typically detected in pesticide process wastewaters. These compounds may be found throughout the pesticide industry as raw materials, impurities in raw materials, or as byproducts of reactions utilizing related compounds such as chlorobenzenes, etc. As an example, it can be concluded from Table 10 that the use of 2,4-dichlorophenol as a raw material will tend to generate variously substituted chlorophenols in process wastewaters. The presence of nitrated phenols is expected in six pesticides. Methylated phenols are not expected to be significant since they are not used as raw materials, but they may appear as impurities of reaction from one pesticide due to use of 4-methylthio-m-cresol as a raw material.

Process descriptions were developed for all the pesticide products listed. These process descriptions were developed and/or checked for applicability to specific plants by reference to the five sources mentioned earlier in this section. The phenolic compound listed for each pesticide product was examined for consistency with process descriptions reviewed. Assumptions were then drawn from this examination to provide a basis for developing the list of phenolic compounds suspected in pesticide waste streams. The assumptions are as follows:

1. When 2,4-dichlorophenol is used as a raw material in the process, then phenol, 2-chloropehnol, and 2,4,6-trichlorophenol are suspected to be present as impurities in the raw material.

2. When 4-nitrophenol is used as a raw material, then phenol is suspected as an impurity in the raw material.

3. When the sodium salt of 4-nitrophenol is used as a raw material then 2-nitrophenol is suspected as an impurity in the raw material.

4. When 4-methylthiophenol is used as a raw material then phenol, 2,4-dichlorophenol, and 2,4,6-trichlorophenol are suspected to be present as impurities in the raw material.

5. When phenylacetate is used as a raw material which reacts with bis (chloroethyl)ether, then phenol is suspected to be a raw material impurity.

6. 2,4-Dichlorophenol was identified by the manufacturer of dicamba and is suspected to be present as an impurity in the raw material.

7. When p-sec-butyl phenol is used as a raw material, then phenol and 2,4-dinitrophenol are suspected to be present as impurities in the raw material.

8. When 4-chlorophenol is used as a raw material, then 2-chlorophenol and 2,4-dichlorophenol are suspected to be present as impurities in the raw material.

9. When PCP is used as a raw material then phenol is suspected to be present as an impurity in the raw material.

10. When dinitro-octylphenol is used as a raw material, then phenol is suspected to be present as an impurity in the raw material.

11. When 4-methylthio-m-cresol is used as a raw material, then 4-chloro-m-cresol is suspected to be present as an impurity in the raw material.

12. When 2,4,5-trichlorophenol is used as a raw material, then 2,4,6-trichlorophenol are suspected to be present as impurities in the raw material.

13. When anisole is used as a raw material, then phenol is suspected to be present as an impurity in the raw material.

14. When p-chloronitrobenzene is used as a raw material, then 2-nitrophenol and 4-nitrophenol are suspected to be present as impurities in the raw material.

15. In certain pesticides, 2-chlorophenol, 2,4-dichlorophenol, and 2,4,6-trichlorophenol are suspected as byproducts of the chlorination reaction.

16. In certain pesticides, phenol, 2-chlorophenol, 2,4-dichlorophenol, and 2,4,6-tirchlorophenol are suspected to be presented as reaction byproducts.

17. When 2,4,5-trichlorophenyl dichlorothiophosphate is used as a raw material, then phenol, 2-chlorophenol, 2,4-dichlorophenol, and 2,4,6-trichlorophenol are suspected to be present as impurities in the raw material.

18. When 2,4-D is used as a raw material, then 2,4-dichlorophenol is suspected to be present as an impurity in the raw material.

19. When thiophenol is used as a raw material, then phenol is suspected to be present as an impurity in the raw material.

20. When 4-chloro-o-cresol is used as a raw material, then 4-chloro-m-cresol and phenol are suspected to be present as impurities in the raw material.

21. When producing certain pesticides, 2-nitrophenol, 4-nitrophenol, and 2,4-dinitrophenol are suspected to be present as reaction byproducts.

22. When pentachlorobenzene undergoes nitration, then pentachlorophenol is suspected to be present as a reaction byproduct.

Polynuclear Aromatics

There are 17 priority pollutant compounds which can be classified as polynuclear aromatics (PNA's). These compounds consist of two or more benzene rings which share a pair of carbon atoms. They are all derived from coal tar, with naphthalene being the single largest constituent. Naphthalene derivatives such as alpha-naphthylamine and alpha-naphthol are used in a number of pesticide processes; therefore, naphthalene is by far the most prevalent PNA priority pollutant in the industry. As shown in Table V-12 acenaphthylene, anthracene, fluorence, fluoranthene, and phenanthrene are found only as raw material impurities. Acenaphthene is found in one pesticide process as a raw material. The remaining ten polynuclear aromatic compounds are not suspected to be present in pesticide processes. Table V-13 lists historical data typically detected in the pesticide process wastewaters.

Process descriptions were developed for all the pesticide products listed. These process descriptions were developed and/or checked for applicability to specific plants by reference to the five sources mentioned earlier in this section. The polynuclear aromatics listed for each pesticide product was examined for consistency with process descriptions reviewed. Assumptions were then drawn from this examination to provide a basis for developing the list of polynuclear aromatics suspected in pesticide waste streams. The assumptions are as follows:

1. When 1-naphthoxide is used as a raw material, then napthalene is suspected to be present as raw material impurity.

2. When a-naphthol is used as a raw material, then napthalene, acenaphthene/acenaphthylene, anthracene/phenanthrene and fluorene/fluoranthene are suspected to be present as impurities in the raw material.

3. When a-naphthylamine is used as a raw material, then napthalene is suspected to be present as impurity in the raw material.

4. When producing the pesticide endrin, naphthalene was identified by the manufacturer and confirmed by wastewater sampling, however the reaction source has not been determined. The suspected presence of 2-chloronapthalene also has been confirmed by wastewater sampling, however the reaction source has not been determined.

5. When acenapthene is used as a raw material, then napthalene is suspected to be present as an impurity in the raw material.

6. When producing certain pesticides, naphthalene is suspected to be present as a reaction byproduct.

Metals

In the pesticide industry metals are used principally as catalysts or as raw materials which are incorporated into the active ingredients, e.g., metallo-organic pesticides. Certain priority pollutant metals which are incorporated into arsenic, cadmium, copper, and mercury based pesticides are included in the scope of this study as a separate segment because they were regulated to a zero discharge of process wastewater to navigable waters during BPT.

Table V-14 contains a coded list of the suspected presence of the compounds in the pesticide industry. Table V-15 lists historical data for pollutants typically detected in the pesticide process wastewaters.

As shown in Table V-14, copper is found or suspected in wastewaters from at least 8 pesticides where it is used as a raw material or catalyst, but is not incorporated into the active ingredient. Of the remaining priority pollutant metals, zinc becomes part of the technical grade pesticide in seven processes; whereas mercury is used as a catalyst in one pesticide process. Manganese and tin-based pesticides are still manufactured; however, these are not priority pollutant metals.

Process descriptions were developed for all the pesticide products listed. These process descriptions were developed and/or checked for applicability to specific plants by reference to the five sources mentioned earlier in this section. The metal listed for each pesticide product was examined for consistency with process descriptions reviewed. Assumptions were then drawn from this examination to provide a basis for developing the list of metals suspected in pesticide waste streams. The assumptions are as follows:

1. When copper is used as a raw material or catalyst in the pesticide process, then it is suspected to be present in pesticide wastewaters.

2. When zinc is used as a raw material or catalyst in the pesticide process, then it is suspected to be present in pesticide wastewaters.

3. When arsenic is used as a raw material or catalyst in the pesticide process, then it is suspected to be present in pesticide wastewaters.

4. When cadmium is used as a raw material or catalyst in the pesticide process, then it is suspected to be present in pesticide wastewaters.

5. When mercury is used as a raw material or catalyst in the pesticide process, then it is suspected to be present in pesticide wastewater.

6. When producing the pesticide acephate, arsenic was identified by the manufacturer as a raw material impurity.

7. When zinc chloride is used as a raw material, then zinc is suspected to be present in pesticide wastewaters.

8. When 0,0-diethyl-0-(4-methylthiophenol)phosphorothioate is used as a raw material, then copper is suspected as a raw material impurity due to its use as a catalyst in the raw material manufacture.

9. When mercury is used as a catalyst, then it is suspected to be present in pesticide wastewater.

10. When 0,0-dimethyl-S-[2-(ethylsulpenyl)ethyl]-phosphorothioate is used as a raw material, then copper is suspected to be present as a raw material impurity due to it as a catalyst in the raw material manufacture.

The other priority pollutant metals (antimony, beryllium, chromium, lead, nickel, selenium, silver, and thallium) may be present as impurities in any pesticide or industrial process wastewaters in trace amounts below the level of treatability due to the following factors:

1. Chromium, copper, nickel, and zinc are used extensively in stainless steel and /or other fabrication metal alloys;

2. Machinery bearings often contain as much as 5 percent antimony, or lead in addition to the other metals present (copper, cadmium, nickel, and zinc);

3. Antimony and arsenic are often found as hardening agents in copper, lead, and other metals or metal alloys;

4. Cadmium and lead are used in fusible alloys and some solders;

5. Corrosion-resistant tank linings and piping often use lead, nickel, and zinc;

6. Arsenic is combined in nature with phosphorous and therefore may enter the plant as a raw material impurity;

7. Cadmium may be an impurity in lime;

8. Chromium is added to noncontact cooling water streams to inhibit slime formation; and

9. Any compound may be found in plant intake water. It is, however, unlikely that thallium, silver, beryllium, or selenium will be found in significant levels in any wastewaters.

Therefore, the above impurities are not included as priority pollutants in the pesticide industry manufacturing processes covered as regulated priority pollutants when these were the only potential sources.

Chlorinated Ethanes and Ethylenes

The chlorinated ethanes and ethylenes are used as solvents, cleaning agents, and intermediates. Vinyl chloride (chloroethylene) is used in the production of plastic polyvinyl chloride. In the pesticide industry approximately 23 products are suspected to contain a member of this group of priority pollutants (Table V-16). The principal pollutants suspected are 1,2-dichloroethane, which is used as a solvent in seven pesticides and tetrachloroethylene, which is used as a solvent in two pesticides. Table V-17 list historical data typically detected in the pesticide process wastewaters.

Process descriptions were developed for all the pesticide products listed. These process descriptions were developed and/or checked for applicability to specific plants by reference to the five sources mentioned earlier in this section. The chlorinated ethane and ethylene compounds listed for each pesticide product were examined for consistency with process descriptions reviewed. Assumptions were then drawn from this examination to provide a basis for developing the list of chlorinated ethane and ethylene compounds suspected in pesticide waste streams. The assumptions are as follows:

1. When 1,2-dichloroethane is used as a solvent in the process, then impurities such as 1,1,2-trichloroethane and 1,1,2,2-tetrachloroethane are suspected to be present.

2. When vinyl chloride is used as a raw material then impurities such as chloroethane are suspected to be present as a raw material impurity.

3. When anhydrous ethyl alcohol and phosphorous pentasulfide are reacted, ethyl dithiophosphone acid results. Upon chlorination of ethyl dithiophosphone into ethyl phosphorochlorodithionate, chloroethane is suspected to be present as a reaction byproduct.

4. When producing the pesticide di(chloroethyl) ether, 1,2-dichloroethane was identified by the manufacturer as a byproduct.

5. When producing the pesticides alachlor, butachlor, and propachlor, 1,2-dichloroethane was identified by the manufacturer as an impurity.

6. When producing the pesticide methamidophos, 1,2-dichloroethane was identified by the manufacturer, however the reaction source has not been determined.

7. When 2,2-dichlorovinyl ethyl ether is used as a raw material, then trichloroethylene is suspected to be present as an impurity in the raw material.

8. When producing the pesticide disulfoton, vinyl chloride was identified by the manufacturer as a reaction byproduct. Vinyl chloride is vented as a gas and incinerated and is therefore suspected to be present in the incinerator scrubber aqueous effluent.

9. When producing the pesticide chlorothalonil, tetrachloroethylene was identified by the manufacturer, however the reaction source has not been determined.

10. When di(chloroethyl) ether is used in the production of certain pesticides then 1,2-dichloroethane is suspected to be present as a solvent impurity.

11. When producing the pesticide toxaphene, tetrachloroethylene was identified by the manufacturer; however, the reaction source has not been determined.

12. When 1,1,2,2-tetrachloroethylsulfenyl chloride (TES) is used as a raw material, then trichloroethylene is suspected as a raw material impurity.

Nitrosamines

N-nitrosamines are a group of compounds characterized by a nitroso group (N=O) attached to the nitrogen of an aromatic or alphatic secondary amine. In the pesticide industry N-nitrosodi-n-propylamine is a suspected reaction byproduct from the nitrosation of di-N-propylamine. Table V-18 shows that 2 pesticides are suspected to contain some form of N-nitrosamine. Table V-19 lists historical data typically detected in pesticide process wastewaters.

Process descriptions were developed for all the pesticide products listed. These process descriptions were developed and/or checked for applicability to specific plants by reference to the five sources mentioned earlier in this section. The nitrosamine compound listed for each pesticide product was examined for consistency with process descriptions reviewed. An assumption was then drawn from this examination to provide a basis for suspecting that N-nitrosodi-n-propylamine is present in pesticide waste streams. The assumption is as follows:

1. When di-n-propylamine is used as a raw material, then N-nitrosodi-n-propylamine is suspected to be present as a reaction byproduct.

Phthalates

Phthalate esters are used widely as plasticizers in commercial polymers and plastic end products such as polyvinylchloride plastics. One phthalate classified as a priority pollutant is suspected to be present in three pesticide processes (see Table V-20). Dimethyl phthalate is known to be a raw material in two products. Table V-21 lists historical data detected in pesticide process wastewaters.

Process descriptions were developed for all the pesticide products listed. These process descriptions were developed and/or checked for applicability to specific plants by reference to the five sources mentioned earlier in this section. The phthalate compound listed for each pesticide product was examined for consistency with process descriptions reviewed. Assumptions were then drawn from this examination to provide a basis for developing the list of phthalate compounds suspected in pesticide waste streams. The assumptions are as follows:

1. When dimethyl phthalate is used as a raw material, then it is suspected to be present in the pesticides wastewaters.

2. When phthalimide is refluxed with methanol, then dimethyl phthalate is suspected to be present as a reaction byproduct.

Dichloropropane and Dichloropropene

1,3-Dichloropropene is a raw material in one pesticide. 1,3-Dichloropropene and the combined pollutants 1,2-dichloropropane - 1,3-dichloropropene are pesticide products as well as priority pollutants and function as insecticidal fumigants.

Process descriptions were developed for all the pesticide products listed. These process descriptions were developed and/or checked for applicability to specific plants by reference to the five sources mentioned earlier in this section (See Table V-22). Table V-23 lists historical data typically detected in pesticide process wastewaters. The dichloropropane and dichloropropene compound listed for each pesticide product was examined for consistency with process descriptions reviewed. Assumptions were then drawn from this examination to provide a basis for developing the list of dichloropropane and dichloropropene compounds suspected in pesticide waste streams. The assumptions are as follows:

1. When 1,3-dichloropropene is used as a raw material in the process, then impurities such as 1,2-dichloropropane are suspected to be present.

2. When 1,3-dichloropropene is produced as a product, then 1,2-dichloropropane is suspected to be present as a reaction byproduct.

3. When allyl chloride is used as a raw material, then 1,2-dichloropropane and 1,3-dichloropropene are suspected to be present as impurities.

4. When propylene oxide is used as a raw material, then 1,2-dichloropropane is suspected to be present as an impurity in the raw material.

5. When vinyl chloride is used as a raw material, then 1,3-dichloropropene is suspected to be present as an impurity in the raw material.

6. When o-iso-propoxyphenol is used as a raw material, then 1,2-dichloropropane and 1,3-dichloropropene are suspected to be present as impurities in the raw material.

7. When 2,3-dichloropropene is used as a raw material, then 1,3-dichloropropene is suspected to be present as a raw material impurity.

Priority Pollutant Pesticides

There are only 18 priority pollutants which are commonly classified as pesticides. Only two priority pollutant pesticides are still in production; heptachlor and chlordane. As shown in Table 24, aldrin, dieldrin, and endrin aldehyde are suspected as reaction byproducts in the endrin process; however, it should be noted that endrin aldehyde occurs as endrin ketone due to thermal rearrangement. Heptachlor epoxide will occur as a reaction byproduct in both chlordane and heptachlor manufacturing. DDD, DDE, and DDT can occur in the manufacture of one pesticide. Endosulfan sulfate can occur as a reaction byproduct in the manufacture of endosulfan. The priority pollutant pesticides BHC, lindane, DDE, DDD, and endosulfan are not currently manufactured, and no raw waste load priority pollutant data are available from past production periods. Table V-25 lists historical data typically detected in the pesticide process wastewaters.

Process descriptions were developed for all the pesticide products listed. These process descriptions were developed and/or checked for applicability to specific plants by reference to the five sources mentioned earlier in this section. The priority pollutant pesticide listed for each pesticide product was examined for consistency with process descriptions reviewed. Assumptions were then drawn from this examination to provide a basis for developing the list of priority pollutant pesticides suspected in pesticide waste streams. The assumptions are as follows:

1. When BHC and lindane are manufactured all isomers of BHC are produced as reaction byproducts.

2. When chlordene and chlorine are used as raw materials, then heptachlor epoxide is suspected to be present as a reaction byproduct. In addition, when chlordane is produced

heptachlor is suspected to be present as a reaction byproduct and when heptachlor is produced chlordane is suspected to be present as a reaction byproduct.

3. When DDT is used as a raw material, then DDD and DDE are suspected to be present as reaction byproducts.

4. When producing the pesticide endosulfan, endosulfan sulfate is suspected to be present as a reaction byproduct.

5. When producing the pesticide endrin, reaction byproducts of aldrin, dieldrin, and endrin aldehyde are suspected to be present. Endrin, endrin aldehyde, and aldrin all can be formed by the Diels-Alder reaction using hexachlorocyclopentadiene as the raw material. Dieldrin is suspected to be present as a reaction byproduct when aldrin is epoxidized.

6. When DDT is produced then DDD and DDE are expected as byproducts. When DDD is produced then DDT and DDE are expected as byproducts. When DDE is produced then DDD and DDT are expected as byproducts.

7. When any of the priority pollutant pesticides are produced then that particular priority pollutant pesticide is expected to be present.

Dienes

There are four manufactured pesticides and two pesticides currently not manufactured which use a priority pollutant diene as a raw material. The basic material for all six pesticides is hexachlorocyclopentadiene (HCCPD). Two pesticides are synthesized by a Diels-Alder condensation of HCCPD and cyclopentadiene to form chlorodene, the intermediate. Chlordene is further chlorinated either by addition or by substitution. One pesticide process involves the stepwise reaction of HCCPD with acetylene, cyclopentadiene, and peroxyacetic acid. Another pesticide is manufactured by the reductive coupling of HCCPD with itself using a cuprous chloride catalyst. As shown in Table 26, the priority pollutant hexachlorobutadiene is suspected to be present in the wastewater because it is a byproduct of HCCPD synthesis and used as a solvent in the manufacture of mirex. Table V-27 lists historical data typically detected in pesticide process wastewaters.

Process descriptions were developoed for all the pesticide products listed. These process descriptions were developed and/or checked for applicability to specific plants by reference to the five sources mentioned earlier in this section. The diene listed for each pesticide product was examined for consistency with process descriptions reviewed. An assumption was then drawn from this examination to procide a basis for suspecting that hexachlorocyclopentadiene is present in pesticide waste streams. The assumption is as follows:

1. When hexachlorocyclopentadiene is used as a raw material, then hexachlorobutadiene is suspected to be present as a byproduct from the raw material synthesis.

TCDD

2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) is believed to be a byproduct in chemical processing generated by a halophenol or chlorobenzene starting material. An intermediate reaction would occur at an elevated temperature, equal to or greater than 160°C, an alkaline condition or in the presence of a free halogen. The end reaction results in either direct dioxin, intermediate dioxin, or predioxin formation which would ultimately form dibenzo-p-dioxins (Dryden, et al., 1979). TCDD is suspected in pesticide wastewaters listed in Table V-28. These pesticides use such raw materials as 2,4,5-trichlorophenol and 1,2,4,5-tetrachlorobenzene which are characteristic of TCDD precursors. The structurally similar pesticides PCP and hexachlorophene are being examined for possible presence of TCDD in wastewater. Analytical procedures are currently being upgraded. A detection limit of 0.002 ug/l (2 nanograms per liter or 2 ng/l) is currently achievable (49 FR 43234, October 26, 1984). Table V-29 lists historical data typically detected in pesticide process wastewaters.

A study of Oswald in 1978 detailed results of analysis of fish samples from three rivers in Michigan for 2,3,7,8-TCDD. Thirty-five samples were analyzed by high resolution capillary column gas chromotography interfaced with high resolution mass spectrometry. Concentrations in 35 samples ranged from 4 ng/l to 695 ng/l.

A TCDD level as high as 111 mg/l has been found in drums of waste from the production of the pesticide 2,4,5-T, according to the Final Rules published May 19, 1980 in the Federal Register. The EPA TCDD task force is currently reviewing the environmental problems of TCDD residue.

Process descriptions were developed for all the pesticide products listed. These process descriptions were developed and/or checked for applicability to specific plants by reference to the five sources mentioned earlier in this section. If TCDD was listed for a pesticide product it was examined for consistency with process descriptions reviewed. An assumption was then drawn from this examination to provide a basis suspecting that TCDD is present in pesticide waste streams. The assumption is as follows:

1. When 2,4,5-trichlorophenol or 1,2,4,5-tetrachlorobenzene are used as raw materials under alkaline conditions or in the presence of a free halogen at temperatures greater than 160°C, then TCDD is suspected to be present as a byproduct from the reaction.

Miscellaneous

Acrolein is manufactured for use in plastics and as a warning agent in methyl chloride refrigerant. It is not indicated, nor has it been found, to be present as a process-related pollutant in the pesticide industry.

Acrylonitrile is used in the manufacture of synthetic fibers, dyes, and adhesives. It is indicated to be present in the one pesticide process where it is suspected to be used as a raw material or solvent. Acrylonitrile has not been monitored in the pesticide industry.

Asbestos is in widespread usage as an insulating material. As shown in Table V-30, total mass chrysotile fibers of asbestos were found in pesticide process wastewaters at concentrations from not detected or 0.000038 mg/l to 0.3 mg/l. These data were reported as part of an EPA asbestos screening sampling program and represents monitoring of combined pesticide and nonpesticide process wastewaters.

1,2-Diphenylhydrazine is a chemical intermediate which is not used, and has not been found in the pesticide industry.

Isophorone is a diene compound (2-cyclohexene-1-one-3,5,5 trimethyl) classified as a priority pollutant. Unlike the other priority pollutant dienes, it is not chlorinated and is not expected, nor has it been found, to be present in any of the processes investigated.

PCBs

For the past 50 years PCBs have had widespread industrial applications as hydraulic fluids, plasticizers in synthetic resins and rubbers, adhesives, heat transfer systems, wax extenders, dedusting agents, pesticide extenders, inks, lubricants, and cutting oils. Most of these uses have been banned, but PCBs are still used in vacuum pumps, gas transmission turbines, and electrical capacitors and transformers.

The only pesticide process where PCBs are likely to occur in the actual manufacturing scheme is Al, where they could be present as reaction byproducts. However, the manufacture of Pesticide Al has recently been ceased and is not anticipated to be produced in the future. Therefore PCBs are no longer indicated to be present in this industry.

Benzidines

Benzidine compounds are synthetically-produced compounds used primarily in the manufacture of dyes. They are not indicated nor have they been found to be present as process-related pollutants in the pesticide industry.

Nitro-substituted Aromatics

Nitro-substituted aromatics are used in the production of explosives, soaps, shoe polish, as chemical intermediates but are not indicated to be present as process-related pollutants in this industry.

NONCONVENTIONAL POLLUTANTS

Typical raw waste load concentrations and flows for nonconventional pollutants are presented in Table V-31 for each of the 280 pesticides for which data are available.

Nonconventional Pesticides

Nonconventional pesticides have been measured in 44 percent of pesticide raw waste streams. Table V-31 presents typical raw waste load concentrations ranging from not detected to 11,200 mg/l.

COD

COD has been monitored in 27 percent of pesticide raw waste streams. Table V-31 presents typical COD concentrations ranging from 14.0 mg/l to 1,220,000 mg/l.

TOC

TOC has been monitored in 11 percent of pesticide raw waste streams. Table V-31 presents typical TOC concentrations ranging from 53.2 mg/l to 79,800 mg/l.

TOD

Raw waste load concentrations of TOD (total oxygen demand) have not been monitored in the pesticide industry.

CONVENTIONAL POLLUTANTS

Typical raw waste load concentrations and flows for conventional pollutants are presented in Table V-32 for each of the 280 pesticides for which data are available.

BOD

BOD has been monitored in 27 percent of pesticide raw waste streams. Table V-19 presents detected BOD concentrations ranging from not detected to 60,000 mg/l. The oxygen demand is quite high as pesticide wastewaters leave the process. This demand must be further evaluated at sampling points immediately prior to biological oxidation systems, since pretreatment steps (such as activated carbon) can effect considerable organic removal.

TSS

TSS has been monitored in 24 percent of pesticide raw waste streams. Table V-32 presents detected TSS concentrations ranging from 2.00 mg/l to 4,090 mg/l.

DESIGN RAW WASTE LOADS

A raw waste load must be selected in order to design and cost recommended treatment and control technologies. The approach taken in this study is to design for the removal of maximum priority pollutant raw waste concentrations as reported in 308 questionnaire for specific plants. This ensured that the economic impact to treat high level pollutants would be adequately considered in a plant-by-plant analysis. A summary of raw waste load design levels is provided in Table V-33.

ZERO-DISCHARGE PRODUCTS

Table V-34 presents a listing of 29 pesticide products which are currently being manufactured with zero discharge of process wastewater to municipal treatment systems or to navigable waterways. This determination was made from examination of process flow diagrams, and from manufacturers' responses to the 308 Survey and follow-up letters. Since no known raw waste load is associated with these products, no treatment is recommended and no costs are developed.

Table V-1. Indicated/Detected Frequency of Priority Pollutant Groups

Priority Pollutant Group	Number of Pesticides in Group	
	Indicated by Process Chemistry Evaluation	Detected in Raw Waste
Volatile Aromatics	118	44
Halomethanes	50	25
Cyanides	24	13
Haloethers	5	4
Phenols	36	20
Polynuclear Aromatics	6	5
Metals	19	8
Chlorinated Ethanes(ylenes)	23	10
Nitrosamines	2	1
Phthalates	3	1
Dichloropropane(ene)	8	3
Pesticides	11	5
Dienes	6	4
TCDD	5	4
Miscellaneous	1	76*
PCBs	0	0
Benzidines	0	0
Nitro-Substituted Aromatics	0	2

* Refers to priority pollutant asbestos only.

Table V-2. Volatile Aromatics Indicated to be Present in Pesticide Process Wastewaters

Pesticide Produced	AROMATICS, CHLORINATED AROMATICS								
	Benzene	Toluene	Ethylbz	Chlorobz	1,2 di-chlorobz	1,3-di-chlorobz	1,4-di-chlorobz	Hexa-chlorobz	1,2,4 TCBz
A1	--	S	--	--	--	--	--	--	--
A2	--	--	--	S	--	--	--	--	--
A3	--	S	--	--	--	--	--	--	--
A4	--	S	--	--	--	--	--	--	--
A5	--	S	--	--	--	--	--	--	--
A6	--	S	--	--	--	--	--	--	--
A7	--	S	--	--	--	--	--	--	--
A8	--	--	--	R	--	--	--	--	--
A9	--	S	--	--	--	--	--	--	--
A10	--	S	--	--	--	--	--	--	--
A11	R	--	--	B	--	--	--	--	--
A12	R	R	--	--	--	--	--	--	--
A13	--	S	--	--	--	--	--	--	--
A14	IS	IS	IS	--	--	--	--	--	--
A15	IS	IS	IS	--	--	--	--	--	--
A16	--	S	--	--	--	--	--	--	--
A17	--	S	--	--	--	--	--	--	--
A18	IS	--	--	IS	--	--	--	--	--
A19	IS	IS	IS	I	--	--	--	--	--
A20	R	--	--	P	--	--	--	--	--
A21	--	S	--	--	--	--	--	--	--
A22	IS	IS	IS	--	--	--	--	--	--
A23	--	S	--	--	--	--	--	--	--
A24	--	S	IS	--	--	--	--	--	--
A25	IS	IS	IS	--	--	--	--	B	--
A26	--	--	--	R	--	--	--	--	--
A27	--	--	--	R	--	--	--	--	--
A28	--	--	--	R	--	--	--	--	--
A29	--	S	--	--	--	--	--	--	--
A30	--	S	--	--	--	--	--	--	--
A31	--	S	--	--	--	--	--	--	--
A32	--	S	--	--	--	--	--	--	--
A33	--	S	--	--	--	--	--	--	--
A34	IS	IS	IS	--	--	--	--	--	--

Footnotes at end of Table

Table V-2. Volatile Aromatics Indicated to be Present in Pesticide Process Wastewaters (Continued, Page 2 of 4)

Pesticide Produced	AROMATICS, CHLORINATED AROMATICS								
	Benzene	Toluene	Ethylbz	Chlorobz	1,2 di-chlorobz	1,3-di-chlorobz	1,4-di-chlorobz	Hexa-chlorobz	1,2,4 TCBz
B1	--	--	--	R	P	--	B	--	--
B2	--	--	--	R	B	--	P	--	--
B3	--	S	--	--	--	--	--	--	--
B4	--	I	--	--	--	--	--	--	--
B5	--	IC	--	I	--	--	--	--	--
B6	--	S	--	--	--	--	--	--	--
B7	S	--	--	--	--	--	--	--	--
B8	I	--	--	--	--	--	--	--	--
B9	--	S	--	--	--	--	--	--	--
B10	--	--	--	S	--	--	--	--	--
C1	--	S	--	--	--	--	--	--	--
C2	--	S	--	--	--	--	--	--	--
C3	--	S	--	--	--	--	--	--	--
C4	--	I	--	--	--	--	--	--	--
C5	--	I	--	--	--	--	--	--	--
C6	IS	IS	IS	--	--	--	--	--	--
C7	--	S	--	I	--	--	--	--	--
C8	--	S	--	--	--	--	--	--	--
C9	--	S	--	--	--	--	--	--	--
C10	--	S	--	--	--	--	--	--	--
C11	--	[illegible]	--	R	--	--	--	--	--
C12	IS	IS	IS	--	--	--	--	--	--
C13	--	S	--	--	--	--	--	--	--
C14	--	S	--	--	--	--	--	--	--
C15	--	S	--	--	--	--	--	--	--
D1	--	S	--	--	--	--	--	--	--
D2	--	I	--	--	--	--	--	--	--
D3	IS	IS	IS	--	--	--	--	--	--
D4	--	S	--	--	--	--	--	--	--
D5	R	--	--	B	--	--	--	--	--
D6	--	--	--	S	--	--	--	--	--
D7	--	S	--	--	--	--	--	--	--
D8	--	S	--	--	--	--	--	--	--
D9	--	S	--	--	--	--	--	--	--
D10	--	S	--	--	--	--	--	--	--

Footnotes at end of table

Table V-2. Volatile Aromatics Indicated to be Present in Pesticide Process Wastewaters (Continued, Page 3 of 4)

Pesticide Produced	AROMATICS, CHLORINATED AROMATICS								
	Benzene	Toluene	Ethylbz	Chlorobz	1,2 di-chlorobz	1,3-di-chlorobz	1,4-di-chlorobz	Hexa-chlorobz	1,2,4 TCBz
E1	—	S	—	—	—	—	—	—	—
E2	—	S	—	—	—	—	—	—	—
E3	—	S	—	—	—	—	—	—	—
E4	S	S	—	—	—	—	—	—	—
E5	—	S	—	S	—	—	—	—	—
E6	—	S	—	—	—	—	—	—	—
E7	—	—	—	S	—	—	—	—	—
E8	IS	IS	IS	—	—	—	—	—	—
E9	—	S	—	—	—	—	—	—	—
E10	—	S	—	—	—	—	—	—	—
F1	—	S	—	—	—	—	—	—	—
F2	IS	IS	IS	—	—	—	—	—	—
F3	IS	IS	IS	—	—	—	—	—	—
F4	—	—	—	—	—	—	—	B	I
F5	IS	IS	IS	—	—	—	—	—	—
F6	—	—	R	—	—	—	—	—	—
F7	—	—	—	R	—	—	—	—	—
F8	—	—	—	R	—	—	—	—	—
F9	—	S	—	—	—	—	—	—	—
F10	S	—	—	—	—	—	—	—	—
G1	S	—	—	—	—	—	—	—	—
G2	—	S	—	S	—	—	—	—	—
G3	S	—	—	—	—	—	—	—	—
G4	IS	IS	IS	—	—	—	—	—	—
G5	—	S	—	—	—	—	—	—	—
G6	—	S	—	—	—	—	—	—	—
G7	—	S	—	—	—	—	—	—	—
G8	IS	IS	IS	—	—	—	—	—	—
G9	—	S	—	—	—	—	—	—	—
G10	—	S	—	—	—	—	—	—	—
G11	—	S	—	—	—	—	—	—	—
G12	—	S	—	—	—	—	—	—	—

Footnotes at end of table

Table V-2. Volatile Aromatics Indicated to be Present in Pesticide Process Wastewaters (Continued, Page 4 of 4)

Pesticide Produced	AROMATICS, CHLORINATED AROMATICS								
	Benzene	Toluene	Ethylbz	Chlorobz	1,2 di-chlorobz	1,3-di-chlorobz	1,4-di-chlorobz	Hexa-chlorobz	1,2,4 TCBz
H1	—	S	—	—	—	—	—	—	—
H2	—	S	—	—	—	—	—	—	—
H3	—	—	—	—	—	—	—	—	I
H4	S	—	—	—	—	—	—	—	—
H5	—	S	—	—	—	—	—	—	—
H6	—	S	—	—	—	—	—	—	—
H7	—	S	—	—	—	—	—	—	—
H8	—	S	—	—	—	—	—	—	—
H9	—	S	—	—	—	—	—	—	—
H10	—	—	—	—	—	U	—	—	—
I1	—	S	—	—	—	—	—	—	—
I2	IS	IS	IS	U	—	—	—	—	—
I3	—	I	—	—	—	—	—	—	—
I4	—	S	—	—	—	—	—	—	—
I5	R	—	—	B	B	B	B	—	B
I6	—	S	—	—	—	—	—	—	—
I7	—	S	—	—	—	—	—	—	—

† = Alpha, beta, and delta isomers.
R = Raw material.
I = Raw material impurity.
S = Solvent.
IS = Solvent impurity
ST = Organic stripper solvent.
IST = Stripper impurity
B = Reaction byproduct.
U = Unknown--pollutant reported by plant, source not determined.
-- = Not suspected.
P = Final product.
IC = Catalyst impurity.
Ethybz - Ethylbenzene
Chlorobz - chlorobenezene
TCBz = Trichlorobenzene

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters

AROMATICS, CHLORINATED AROMATICS

BENZENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	0.0315
1	ND	(1)	0.0315
2	0.073	(3)	0.012
3	0.0877	(16)	0.0391
4	0.0877	(16)	0.0391
5	<0.10	(2)	2.3
6	0.220	(3)	28.2
7	0.220	(3)	28.2
8	0.220	(3)	28.2
9	0.220	(3)	28.2
10	0.220	(3)	28.2
11	0.580*	(1)	1.8
12	2.68	(3)	1.241
13	3.00	(22)	0.00156
14	52*	(111)	0.094
15	52*	(111)	0.094
16	52*	(111)	0.094
17	52*	(111)	0.094
18	180,000	(1)	0.000276
1	30	(1)	1.5
1	0.580*	(1)	1.8
1	0.07	(1)	0.7224
2	0.07	(1)	0.7224
1	0.0051	(2)	0.009
2	<0.010*	(3)	0.1027
3	<0.01*	(1)	1.22
4	<0.10	(2)	2.3
5	0.220	(3)	28.2
6	<0.30	(3)	0.084

ND = Not detected.
* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
= Analysis not conducted per protocol.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 2 of 11)

AROMATICS, CHLORINATED AROMATICS

BENZENE

Plant	Conc. mg/l	(n)	Flow (MGD)
7	0.580*	(1)	1.8
8	0.767	(3)	0.0717
9	2.68	(3)	1.241
1	2.68	(3)	1.241

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* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 3 of 11)

AROMATICS, CHLORINATED AROMATICS

TOLUENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.137	(1)	0.030
2	<69.3	(5)	0.0665
1	Trace	(1)	NA
2	0.030	(3)	0.012
3	0.137	(1)	0.030
4	0.180*	(1)	1.8
5	0.21*	(1)	1.8
6	1.40	(3)	2.3
7	1.49	(10)	0.130
8	5.40	(3)	28.2
9	5.40	(3)	28.2
10	5.40	(3)	28.2
11	7.42	(2)	2.3
12	11.7	(E)	0.161
13	15.3	(3)	1.241
14	350	(1)	0.000054
15	294,000	(1)	0.000276
1	0.180*	(1)	1.8
2	20,000	(1)	0.00118
1	0.10*	(1)	0.7224
2	0.10*	(1)	0.7224
1	ND	(3)	0.3283
2	<0.0050	(2)	0.009
3	<0.01*	(1)	1.22
4	0.016*	(3)	0.1027
5	0.180*	(1)	1.8
6	0.21*	(1)	1.8
7	5.40	(3)	28.2
8	15.3	(3)	1.241

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(E) = Estimate.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 4 of 11)

AROMATICS, CHLORINATED AROMATICS

TOLUENE

Plant	Conc. mg/l	(n)	Flow (MGD)
9	28.5*	(1)	0.20
10	28.5*	(1)	0.20
11	28.5*	(1)	0.20
12	370*	(20)	0.021
13	528	(3)	0.101
14	686	(30)	0.101
15	1,570	(28)	0.101
1	2.69*	(540)	2.5
2	2.69*	(540)	2.5
3	2.69*	(540)	2.5
4	5.80*	(270)	1.3
5	5.80*	(270)	1.3
6	5.80*	(270)	1.3
7	15.3	(3)	1.241

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* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 5 of 11)

AROMATICS, CHLORINATED AROMATICS

ETHYLBENZENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.338	(1)	0.030
1	<0.005	(3)	0.012
2	0.203	(2)	2.3
3	0.338	(1)	0.030
4	1.00	(1)	2.3
5	7.90	(3)	28.2
6	7.90	(3)	28.2
7	7.90	(3)	28.2
1	ND*	(1)	1.8
1	<0.01	(1)	6,050 gal/ 1,000 lbs
1	ND*	(1)	1.8
2	ND	(2)	0.009
3	<0.01*	(1)	1.22
4	7.90	(3)	28.2

ND = Not detected.
* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 6 of 11)

AROMATICS, CHLORINATED AROMATICS

CHLOROBENZENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND*	(1)	NA
2	<0.005*	(1)	0.00002
3	<0.005*	(1)	0.00002
4	0.195	(16)	0.0391
5	0.195	(16)	0.0391
6	3.0	(3)	28.2
7	3.0	(3)	28.2
8	3.0	(3)	28.2
9	3.0	(3)	28.2
10	3.0	(3)	28.2
11	135*	(111)	0.094
12	135*	(111)	0.094
13	135*	(111)	0.094
14	135*	(111)	0.094
1	0.30*	(1)	NA
2	0.30*	(1)	NA
1	<0.01	(3)	0.0033
2	<0.01	(3)	1.22
3	3.0	(3)	28.2
4	3.77	(2)	2.3
5	6.31	(3)	0.0717
6	5.00	(3)	2.3
7	979	(1)	0.0163
1	ND	(1)	NA

ND = Not detected.
NA = Not available.
* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
= Analysis not conducted per protocol.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 7 of 11)

AROMATICS, CHLORINATED AROMATICS

1,2-DICHLOROBENZENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.023	(3)	28.2
2	0.023	(3)	28.2
3	0.023	(3)	28.2
4	0.023	(3)	28.2
5	0.023	(3)	28.2
6	0.023	(3)	28.2
7	127*	(111)	0.094
8	127*	(111)	0.094
9	127*	(111)	0.094
10	127*	(111)	0.094
1	ND	(1)	NA
2	ND	(1)	2.3
3	0.023*	(3)	28.2
4	<0.113	(3)	0.0033

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 8 of 11)

AROMATICS, CHLORINATED AROMATICS

1,3-DICHLOROBENZENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.410	(3)	28.2
2	0.410	(3)	28.2
3	0.410	(3)	28.2
4	0.410	(3)	28.2
5	0.410	(3)	28.2
6	127*	(111)	0.094
7	127*	(111)	0.094
8	127*	(111)	0.094
9	127*	(111)	0.094
1	ND	(1)	NA
2	ND	(1)	NA
3	<0.120	(3)	2.3
4	0.410*	(3)	28.2

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 9 of 11)

AROMATICS, CHLORINATED AROMATICS

1,4-DICHLOROBENZENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	NA
1	0.470	(3)	28.2
2	0.470	(3)	28.2
3	0.470	(3)	28.2
4	0.470	(3)	28.2
5	0.470	(3)	28.2
6	85*	(111)	0.094
7	85*	(111)	0.094
8	85*	(111)	0.094
9	85*	(111)	0.094
1	ND	(1)	NA
2	ND	(1)	2.3
3	ND	(1)	NA
4	0.470*	(3)	28.2

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 10 of 11)

AROMATICS, CHLORINATED AROMATICS

HEXACHLOROBENZENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	NA
1	ND	(1)	NA
2	ND*	(1)	NA
3	ND*	(1)	NA
4	ND	(1)	2.3
5	<0.008	(2)	0.0033

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 11 of 11)

AROMATICS, CHLORINATED AROMATICS

1,2,4-TRICHLOROBENZENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	NA
2	36*	(47)	0.094
3	36*	(47)	0.094
4	36*	(47)	0.094
5	36*	(47)	0.094
1	ND	(1)	2.3
2	0.0296	(2)	0.0033

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-4. Halomethanes Indicated to be Present in Pesticide Process Wastewaters

Pesticide Produced	HALOMETHANES							
	Methyl chlorine	Methyl bromide	Methylene chloride	Chloro-form	Bromo-form	Dichloro-bromo-methane	Chloro-dibromo-methane	Carbon tetra-chlorine
A1	--	--	ST	--	--	--	--	--
A2	B	--	--	--	--	--	--	--
A3	--	--	ST	--	--	--	--	--
A4	--	--	--	--	--	--	--	I
A5	--	--	--	--	--	--	--	I
A6	R	--	--	--	--	--	--	--
A7	--	--	S	--	--	--	--	--
A8	--	--	S	--	--	--	--	--
A9	B	--	S,B	B	--	--	--	B
A10	--	--	S	--	--	--	--	--
A11	--	--	--	--	--	--	--	S
B1	--	--	S	--	--	--	--	--
B2	--	--	S	--	--	--	--	--
B3	B	--	B,S	B	--	--	--	B
B4	--	--	ST	--	--	--	--	--
B5	--	--	ST	--	--	--	--	--
B6	--	--	I	--	--	--	--	--
B7	--	--	I	--	--	--	--	--
B8	--	--	--	--	--	--	--	S
B9	R	--	--	--	--	--	--	--
B10	B	--	--	--	--	--	--	--
B11	--	--	--	--	--	--	--	I
C1	--	--	S	--	--	--	--	--
C2	B	--	B,S	B	--	--	--	B
C3	--	I	I	--	I	--	--	--
C4	--	--	--	--	U	--	--	--
C5	--	--	--	I	--	--	--	--
C6	--	--	--	S	--	--	--	--
C7	--	--	--	--	--	--	--	S
C8	--	--	S	--	--	--	--	--
C9	--	--	--	--	--	--	--	I
C10	--	--	S	--	--	--	--	--
D1	--	P	--	--	--	--	--	--
D2	--	I	I	--	I	--	--	--
D3	--	R	--	--	--	--	--	--
D4	B	--	--	--	--	--	--	--

Footnotes at end of table

Table V-4. Halomethanes Indicated to be Present in Pesticide Process Wastewaters (Continued, Page 2 of 2)

	HALOMETHANES							
Pesticide Produced	Methyl chlorine	Methyl bromide	Methylene chloride	Chloroform	Bromoform	Dichlorobromomethane	Chlorodibromomethane	Carbon tetrachlorine
D5	B	--	B,S	B	--	--	--	B
D6	B	--	--	S	--	--	--	--
D7	--	--	--	--	--	--	--	S
D8	--	--	--	--	--	--	--	I
D9	R	--	--	--	--	--	--	--
D10	B	--	B,S	B	--	--	--	B
E1	--	--	--	--	--	--	--	S
E2	--	--	--	--	--	--	--	I
E3	--	--	--	--	--	--	--	I
E4	B	--	--	--	--	--	--	--
E5	--	--	S	--	--	--	--	--
E6	--	--	S	--	--	--	--	--
E7	--	--	--	--	--	--	--	S
E8	B	--	B,S	B	--	--	--	B

R = Raw material.
I = Raw material impurity.
S = Solvent.
IS = Solvent impurity.
ST = Organic stripper solvent.
IST = Stripper impurity.
B = Reaction byproduct.
-- = Not suspected.
P = Final product.

Methyl chloride = (Chloromethane).
Methyl bromide = (Bromomethane).
Methylene chloride = (Dichloromethane).
Chloroform = (Trichloromethane).
Bromoform = (Tribromomethane).
Carbon tetrachloride = (Tetrachloride).

Table V-5. Halomethanes Detected in Pesticide Process Wastewaters

HALOMETHANES

METHYL CHLORIDE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	NA
2	ND*	(1)	NA
3	<1.0*	(1)	0.008
1	ND	(1)	NA
2	ND*	(1)	NA
1	ND	(1)	0.7224
1	ND	(3)	0.3283
2	ND*	(1)	NA
3	ND	(1)	NA

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
= Analysis not conducted per protocol.
(n) = Number of data points.

Table V-5. Halomethanes Detected in Pesticide Process Wastewaters (Continued, Page 2 of 7)

HALOMETHANES

METHYL BROMIDE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	1.10	(3)	28.2
2	53.8	(2)	0.0086
3	2,600	(1)	0.0086

= Data from comingled pesticide/other product stream.
(n) = Number of data points.

Table V-5. Halomethanes Detected in Pesticide Process Wastewaters (Continued, Page 3 of 7)

HALOMETHANES

METHYLENE CHLORIDE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	None	(E)	0.0451
2	12.7	(3)	0.00323
1	0.010*	(1)	1.8
2	<0.010	(3)	0.154
3	0.017*	(2)	1.034
4	0.0233	(3)	0.154
5	0.453*	(3)	0.110
6	0.55*	(1)	1.8
7	4.17	(3)	2.3
8	<75.2	(2)	0.022
9	76.0	(2)	2.3
10	31,000	(50)	0.0014
1	<0.01*	(1)	NA

NA = Not available.
* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product stream.
= Analysis not conducted per protocol.
(E) = Estimate.
(n) = Number of data points.

Table V-5. Halomethanes Detected in Pesticide Process Wastewaters (Continued, Page 4 of 7)

HALOMETHANES

CHLOROFORM

Plant	Conc. mg/l	(n)	Flow (MGD)
1	<0.30	(3)	0.00323
1	0.0149	(3)	1.24
2	<0.029	(2)	0.022
3	0.0367	(3)	0.154
4	0.111	(2)	2.3
5	0.170	(3)	0.154
6	0.200*	(1)	1.8
7	<1.55*	(3)	0.110
8	70.0*	(10)	0.043
1	70.0*	(10)	0.043
2	3,000	(2)	0.021
1	0.017*	(1)	NA
1	0.382*	(3)	0.1893
2	0.623*	(3)	1.22
3	6.31	(3)	0.0717

NA = Not available.
* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product stream.
= Analysis not conducted per protocol.
(n) = Number of data points.

Table V-5. Halomethanes Detected in Pesticide Process Wastewaters (Continued, Page 5 of 7)

HALOMETHANES

BROMOFORM

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	0.0533
1	ND	(3)	2.3
2	<0.010	(2)	2.3
1	ND	(1)	1.8

ND = Not detected.
= Data from comingled pesticide/other product stream.
(n) = Number of data points.

Table V-5. Halomethanes Detected in Pesticide Process Wastewaters (Continued, Page 6 of 7)

HALOMETHANES

DICHLOROBROMOMETHANE

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

CHLORODIBROMOMETHANE

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

Table V-5. Halomethanes Detected in Pesticide Process Wastewaters (Continued, Page 7 of 7)

HALOMETHANES

CARBON TETRACHLORIDE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(3)	0.154
2	<0.001	(3)	0.022
3	<0.010	(2)	2.3
4	<0.010	(3)	0.154
5	0.025	(3)	2.3
1	10.5*	(3)	1.22
2	67.9*	(3)	0.1893
3	67.9*	(3)	0.1893
4	121	(3)	0.0717
1	<0.160*	(270)	1.3
2	<0.160*	(270)	1.3
3	<0.160*	(270)	1.3
4	0.168*	(540)	2.5
5	0.168*	(540)	2.5
6	0.168*	(540)	2.5

ND = Not detected.
* = Data from comingled pesticide stream.
= Data from comingled pesticide/other product stream.
(n) = Number of data points.

Table V-6. Cyanides Indicated to be present in Pesticide Process Wastewaters

Pesticide Produced	Raw Material	Potential Cyanide Contamination
A	Atrazine	I, B
B	Cyanuric chloride	I, B
C	Cyanuric chloride	I, B
D	Methyl cyanocarbamate	I
E	Dichlorobenzil	I
F	Isophthalodinitrile	I
G	Cyanuric chloride	I, B
	Aminoisobutyronitrile	I
H	Azobisisobutyronitrile	IC
I	Cyanamide	I
J	Soduim cyanate	I
K	Sodium thiocyanate	I
L	Cyanamide 50	I
M	Sodium thiocyanate	I
N	Cyanamide	I
O	2-Cyanopyridine	I
P	Propazine	I, B
Q	Propazine	I, B
R	Cyanuric chloride	I, B
S	Cyanuric chloride	I, B
T	Simazine	I, B
U	Ammonium thiocyanate	I
V	Cyanuric chloride	I, B
W	Terbuthylazine	I, B
X	Thiazole	I

R = Raw material.
I = Raw material impurity
B = Reaction byproduct.
IC = Catalyst impurity.

Table V-7. Cyanides Detected in Pesticide Process Wastewaters

CYANIDE

CYANIDE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	0.0202
1	1.22*	(772)	1.42
1	ND*	(270)	1.3
2	ND*	(270)	1.3
3	ND*	(270)	1.3
4	0.105*	(540)	2.5
5	0.105*	(540)	2.5
6	0.105*	(540)	2.5
7	1.22*	(772)	1.42
8	1.22*	(772)	1.42
9	1.22*	(772)	1.42
10	1.22*	(772)	1.42
11	1.22*	(772)	1.42
12	1.22*	(772)	1.42
13	1.22*	(772)	1.42
14	2.16*	(3)	1.2412
15	3.02	(44)	NA
16	5.04	(34)	NA
17	5,503	(3)	0.0634

NA = Not available.
ND = Not detected.
= Data from comingled pesticide/other product streams.
* = Data from comingled pesticide streams.
= Analysis not conducted per protocol.
(n) = Number of data points.

Table V-8. Halogenated Ether Indicated to be Present in Pesticide Process Wastewaters

Pesticide Produced	PRIORITY POLLUTANT HALOGENATED ETHER bis(2-chloroethyl) ether
AA	S
BB	P
CC	I
DD	R
EE	I

R = Raw material.
I = Raw material impurity.
B = Reaction byproduct.
P = Final product.
S = Solvent.

Table V-9. Haloethers Detected in Pesticide Process Wastewaters

PRIORITY POLLUTANT HALOGENATED ETHER

BIS(2-CHLOROETHYL) ETHER

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	0.030
1	ND	(1)	NA
1	0.582	(3)	1.49

NA = Not available.
ND = Not detected.
= Data from comingled pesticide/other product streams.
(n) = Number of data points.

2-CHLOROETHYL VINYL ETHER

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	0.03
1	ND	(1)	NA

NA = Not available.
ND = Not detected.
(n) = Number of data points.

Table V-9. Haloethers Detected in Pesticide Process Wastewaters (Continued, Page 2 of 3)

PRIORITY POLLUTANT HALOGENATED ETHER

BIS(2-CHLOROISOPROPYL) ETHER

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	0.03
1	ND	(1)	NA

NA = Not available.
ND = Not detected.
(n) = Number of data points.

BIS(2-CHLOROETHOXY) METHANE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	0.03
1	ND	(1)	NA

NA = Not available.
ND = Not detected.
(n) = Number of data points.

Table V-9. Haloethers Detected in Pesticide Process Wastewaters (Continued, Page 3 of 3)

PRIORITY POLLUTANT HALOGENATED ETHER

4-CHLOROPHENYL PHENYL ETHER

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	NA
2	ND	(1)	0.03

NA = Not available.
ND = Not detected.
(n) = Number of data points.

4-BROMOPHENYL PHENYL ETHER

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

Table V-10. Phenols Indicated to be Present in Pesticide Process Wastewaters

Pesticide Produced	AROMATICS, CHLORINATED AROMATICS								
	P	2-CP	24-DCP	246-TCP	PCP	2-NP	4-NP	24-DNP	4-CMC
A	I	I	R	I	—	—	—	—	—
B	I	—	I	—	—	—	—	—	—
C	I,B	—	—	—	—	—	—	—	—
D	I	I	R	I	—	—	—	—	—
E	I	I	R	I	—	—	—	—	—
F	—	—	I	—	—	—	—	—	—
G	—	—	I	—	—	—	—	—	—
H	—	—	I	—	—	—	—	—	—
I	—	—	I	—	—	—	—	—	—
J	I	I	R	I	—	—	—	—	—
K	—	I	I	—	—	—	—	—	—
L	I	I	R	I	—	—	—	—	—
M	I	—	—	—	—	B	B	B	—
N	I	—	—	—	—	—	—	I	—
O	I	—	—	—	—	—	R	—	—
P	B	—	—	—	—	—	—	—	—
Q	—	—	—	—	—	—	—	—	I
R	I	—	—	—	—	—	—	—	—
S	I	I	I	I	—	—	—	—	—
T	I	—	—	—	—	—	—	—	I
U	I	—	—	—	—	—	—	—	I
V	I	—	—	—	—	—	—	—	—
W	I	I	R	I	—	I	I	—	—
X	—	—	—	—	—	I	R	—	—
Y	—	—	—	—	—	I	R	—	—
Z	—	—	—	—	B	—	—	—	—
AA	R	B	B	B	P	—	—	—	—
BB	I	—	—	—	R	—	—	—	—
CC	B	B	B	B	—	—	—	—	—
DD	B	B	B	B	—	—	—	—	—
EE	I	I	I	I	—	—	—	—	—
FF	I	I	I	I	—	—	—	—	—
GG	I	I	I	I	—	—	—	—	—
HH	I	I	R	I	—	—	—	—	—
II	—	I	I	—	—	—	—	—	—
JJ	I	I	I	I	—	—	—	—	—

P = Phenol.
2-CP = 2-Chlorophenol.
24-DCP = 2,4-Dichlorophenol.
246-TCP = 2,4,6-Trichlorophenol.
PCP = Pentachlorophenol.
2-NP = 2-Nitrophenol.
4-NP = 4-Nitrophenol.
24-DNP = 2,4-Dinitrophenol.
4-CMC = 4-Chloro-m-cresol (parachlorometa cresol).
24-DMP = 2,4-Dimethylphenol.
R = Raw material.
I = Raw material impurity.
B = Reaction byproduct.
P = Final product.
— = Not suspected.

Table V-11. Phenols Detected in Pesticide Process Wastewaters

PHENOLIC PRIORITY POLLUTANTS

PHENOL

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.27*	(1)	1.8
2	0.290	(3)	28.2
3	0.290	(3)	28.2
4	0.290	(3)	28.2
5	<0.51	(3)	0.022
6	16.0*	(21)	0.065
7	47.0*	(1)	0.00002
8	47.0*	(1)	0.00002
9	61.8	(762)	0.124
1	0.290	(3)	28.2
2	<1.82*	(3)	0.120
3	44.1*	(31)	0.138
4	<110*	(337)	0.20
5	<110*	(337)	0.20
6	<110*	(337)	0.20
7	200*	(312)	0.20
8	200*	(312)	0.20
9	200*	(312)	0.20
10	280	(3)	0.015
11	1,101	(22)	0.0035

= Data from comingled pesticide/other product streams.
* = Data from comingled pesticide streams.
** = Total phenols.
= Reported as total phenols.
(n) = Number of data points.

Table V-11. Phenols Detected in Pesticide Process Wastewaters
(Continued, Page 2 of 7)

PHENOLIC PRIORITY POLLUTANTS

2-CHLOROPHENOL

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.062	(3)	28.2
2	0.062	(3)	28.2
3	0.062	(3)	28.2
4	3.00*	(21)	0.065
5	<5.00*	(1)	0.00002
6	<5.00*	(1)	0.00002
7	30.5	(3)	0.022
8	<1,000	(8)	0.02
1	0.062	(3)	28.2
2	<5.09*	(31)	0.138
3	11.2*	(3)	0.120

---

* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-11. Phenols Detected in Pesticide Process Wastewaters (Continued, Page 3 of 7)

PHENOLIC PRIORITY POLLUTANTS

2,4-DICHLOROPHENOL

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.042*	(2)	1.8
2	0.042*	(2)	1.8
3	0.290	(3)	28.2
4	0.290	(3)	28.2
5	0.290	(3)	28.2
6	<5.00*	(1)	0.00002
7	<5.00*	(1)	0.00002
8	<7.74*	(301)	0.0960
9	<7.74*	(301)	0.0960
10	15.0*	(21)	0.065
11	118	(3)	0.022
12	>1,000	(9)	0.02
13	3,000	(1)	0.002
14	3,600	(1)	0.00125
15	6,650	(6)	0.0034
1	0.290	(3)	28.2
2	9.08	(30)	0.101
3	36.0	(3)	0.3283
4	53.7*	(3)	0.120
5	92.2*	(31)	0.138
6	42,000	(3)	0.015

---

* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-11. Phenols Detected in Pesticide Process Wastewaters (Continued, Page 4 of 7)

PHENOLIC PRIORITY POLLUTANTS

2,4,6-TRICHLOROPHENOL

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.022*	(2)	1.8
2	0.110	(3)	28.2
3	0.110	(3)	28.2
4	0.110	(3)	28.2
5	3.00*	(21)	0.065
6	<5.00*	(1)	0.00002
7	<5.00*	(1)	0.00002
8	<100	(8)	0.02
9	481	(3)	0.022
1	0.110	(3)	28.2
2	<0.794	(30)	0.101
3	2.20*	(3)	0.120
4	<3.69*	(31)	0.138
5	8,700	(3)	0.015

---

* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-11. Phenols Detected in Pesticide Process Wastewaters (Continued, Page 5 of 7)

PHENOLIC PRIORITY POLLUTANTS

PENTACHLOROPHENOL

Plant	Conc, mg/l	(n)	Flow (MGD)
1	1.00*	(21)	0.065
2	>1,000	(9)	0.02

---

* = Data from comingled pesticide streams.
(n) = Number of data points.

2-NITROPHENOL

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

Table V-11. Phenols Detected in Pesticide Process Wastewaters (Continued, Page 6 of 7)

PHENOLIC PRIORITY POLLUTANTS

4-NITROPHENOL

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.002	(1)	0.006
1	174	(121)	0.215
2	461*	(610)	0.75
3	461*	(610)	0.75

---

* = Data from comingled pesticide streams.
(n) = Number of data points.

2,4-DINITROPHENOL

Plant	Conc. mg/l	(n)	Flow (MGD)
1	7.91	(4)	1.06

= Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-11. Phenols Detected in Pesticide Process Wastewaters
(Continued, Page 7 of 7)

PHENOLIC PRIORITY POLLUTANTS

PARACHLOROMETA CRESOL

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

- -

2,4-DIMETHYLPHENOL

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

- -

4,6-DINITRO-O-CRESOL

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

- -

Table V-12. Polynuclear Aromatic Hydrocarbons Indicated to be Present in Pesticide Process Wastewaters

	POLYNUCLEAR AROMATIC PRIORITY POLLUTANTS				
Pesticide Product	Naphthalene	2-Chloro-naphthalene	Acenaphthene Acenaphthylene	Anthracene phenanthrene	Fluorene Fluoranthene
A	B	—	—	—	—
B	I	—	—	—	—
C	U	U	—	—	—
D	I	—	I	I	I
E	I	—	—	—	—
F	I	—	R	—	—

I = Raw material impurity.
— = Not suspected.
U = Unknown--pollutant reported by plant, source not determined.

Table V-13. Polynuclear Aromatic Hydrocarbons Detected in Pesticide Process Wastewaters

POLYNUCLEAR AROMATIC PRIORITY POLLUTANTS

NAPHTHALENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.066*	(3)	28.2
2	0.066*	(3)	28.2
1	ND	(1)	NA
2	1.06*	(3)	0.1893

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

2-CHLORONAPHTHALENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	NA
2	<0.01*	(1)	0.189

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-13. Polynuclear Aromatic Hydrocarbons Detected in Pesticide Process Wastewaters (Continued, Page 2 of 4)

POLYNUCLEAR AROMATIC PRIORITY POLLUTANTS

ACENAPHTHENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	NA

NA = Not available.
ND = Not detected.
(n) = Number of data points.

ACENAPHTHYLENE

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

Table V-13. Polynuclear Aromatic Hydrocarbons Detected in Pesticide Process Wastewaters (Continued, Page 3 of 4)

POLYNUCLEAR AROMATIC PRIORITY POLLUTANTS

ANTHRACENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	NA

NA = Not available.
ND = Not detected.
(n) = Number of data points.

PHENANTHRENE

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

Table V-13 Polynuclear Aromatic Hydrocarbons Detected in Pesticide Process Wastewaters (Continued, Page 4 of 4)

POLYNUCLEAR AROMATIC PRIORITY POLLUTANTS

FLUORENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	NA

NA = Not available.
ND = Not detected.
(n) = Number of data points.

FLUORANTHENE

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

Table V-14. Metals Indicated to be Present in Pesticide Process Wastewaters

Pesticide Produced	PRIORITY POLLUTANT METAL				
	Hg	As	Cu	Zn	Cd
A	—	I	—	—	—
B	C	—	—	—	—
C	—	—	C	—	—
D	—	—	C	—	—
E	—	—	C	—	—
F	—	—	C	—	—
G	—	—	C	—	—
H	—	—	C	—	—
I	—	—	I	—	—
J	—	—	—	R	—
K	—	—	—	R	—
L	—	—	R	—	—
M	—	—	I	—	—
N	—	—	—	C	—
O	—	—	—	R	—
P	—	—	—	R	—
Q	—	—	—	R	—
R	—	—	—	R	—
S	—	—	—	R	—
T	R	R	R	—	R

C = Catalyst.
R = Raw material.
I = Impurities in raw materials or catalysts.
— = Not suspected.

Table V-15. Metals Detected in Pesticide Process Wastewaters

PRIORITY POLLUTANT METAL

ARSENIC

Plant	Conc. mg/l	(n)	Flow (MGD)
1	2.0	(12)	0.27

COPPER

Plant	Conc. mg/l	(n)	Flow (MGD)
1	1.0	(1)	0.03
1	ND*	(1)	1.8
2	0.05*	(1)	1.8
1	ND*	(1)	1.8
2	4,500	(325)	0.021
3	5,350*	(72)	0.016
4	47,000	(1)	0.000946
5	59,000	(1)	0.001
1	0.204	(3)	1.24

ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-15. Metals Detected in Pesticide Process Wastewaters (Continued, Page 2 of 2)

PRIORITY POLLUTANT METAL

NICKEL

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

ZINC

Plant	Conc. mg/l	(n)	Flow (MGD)
1	247*	(2)	0.0749
2	247*	(2)	0.0749

* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-16. Chlorinated Ethanes and Ethylenes Indicated to be Present in Pesticide Process Wastewaters

Pesticide Produced	CHLORINATED ETHANES AND ETHYLENES											
	CE	1,2 DCE	1,1 DCE	1,1,1 TCE	1,1,2 TCE	1,1,2,2 TETCE	Hexa-CE	CET	1,1-DCET	1,2-Trans DCET	TCET	Tetra-CET
A	—	I	—	—	—	—	—	—	—	—	—	—
B	—	S	—	—	IS	IS	—	—	—	—	—	—
C	—	S	—	—	IS	IS	—	—	—	—	—	—
D	—	S	—	—	IS	IS	—	—	—	—	—	—
E	—	IS	—	—	—	—	—	—	—	—	—	—
F	—	I	—	—	—	—	—	—	—	—	—	—
G	—	—	—	—	—	—	—	—	—	—	I	—
H	—	—	—	—	—	—	—	—	—	—	—	S
I	—	—	—	—	—	—	—	—	—	—	—	U
J	—	B	—	—	—	—	—	—	—	—	—	—
K	—	S	—	—	IS	IS	—	—	—	—	—	—
L	—	—	—	—	—	—	—	B	—	—	—	—
M	I	—	—	—	—	—	—	R	—	—	—	—
N	—	S	—	—	IS	IS	—	—	—	—	—	—
O	—	U	—	—	—	—	—	—	—	—	—	—
P	—	—	—	—	—	—	—	—	—	—	—	S
Q	B	—	—	—	—	—	—	—	—	—	—	—
R	—	IS	—	—	—	—	—	—	—	—	—	—
S	—	—	—	—	—	—	—	—	—	—	I	—
T	—	I	—	—	—	—	—	—	—	—	—	—
U	—	S	—	—	IS	IS	—	—	—	—	—	—
V	—	S	—	—	IS	IS	—	—	—	—	—	—
W	—	—	—	—	—	—	—	—	—	—	—	U

R = Raw material
I = Raw material impurity.
S = Solvent.
IS = Solvent impurity.
ST = Organic stripper solvent.
IST = Stripper impurity.
B = Reaction byproduct.
U = Unknown--pollutant reported by plant, source not determined.
— = Not suspected.

CE = Chlorethane.
DCE = Dichloroethane.
TCE = Trichloroethane.
TETCE = Tetrachloroethane.
CET = Vinyl chloride (Chloroethylene)
DCET = Dichloroethylene.
TCET = Trichloroethylene.

Table V-17. Chlorinated Ethanes and Ethylenes Detected in Pesticide Process Wastewaters

CHLORINATED ETHANES AND ETHYLENES

CHLOROETHANE

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

1,2-DICHLOROETHANE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	NA
2	0.010*	(1)	1.8
3	0.37*	(1)	1.8
4	10,000	(3)	0.0002
1	0.37*	(1)	1.8
1	0.010*	(1)	1.8

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-17. Chlorinated Ethanes and Ethylenes Detected in Pesticide Process Wastewaters (Continued, Page 2 of 6)

CHLORINATED ETHANES AND ETHYLENES

1,1-DICHLOROETHANE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND*	(1)	NA
2	ND*	(1)	NA
1	ND*	(1)	NA

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

1,1,1-TRICHLOROETHANE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(1)	NA
1	ND*	(1)	NA
2	ND*	(1)	NA
1	ND*	(1)	NA

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-17. Chlorinated Ethanes and Ethylenes Detected in Pesticide Process Wastewaters (Continued, Page 3 of 6)

CHLORINATED ETHANES AND ETHYLENES

1,1,2-TRICHLOROETHANE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.020*	(1)	1.8
1	0.020*	(1)	1.8

* = Data from comingled pesticide streams.
(n) = Number of data points.

1,1,2,2-TETRACHLOROETHANE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	1.70*	(1)	1.8
1	ND*	(1)	NA
2	1.70*	(1)	1.8
1	1.70*	(1)	1.8

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-17. Chlorinated Ethanes and Ethylenes Detected in Pesticide Process Wastewaters (Continued, Page 4 of 6)

CHLORINATED ETHANES AND ETHYLENES

HEXACHLOROETHANE

Plant	Conc. mg/l	(n)	Flow (MGD)
No data available.			

- -

VINYL CHLORIDE

Plant	Conc. mg/l	(n)	Flow (MGD)
No data available.			

- -

Table V-17. Chlorinated Ethanes and Ethylenes Detected in Pesticide Process Wastewaters (Continued, Page 5 of 6)

CHLORINATED ETHANES AND ETHYLENES

1,1-DICHLOROETHYLENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND*	(1)	NA
2	ND*	(1)	NA
1	ND*	(1)	NA

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

1,2-TRANS-DICHLOROETHYLENE

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

Table V-17. Chlorinated Ethanes and Ethylenes Detected in Pesticide Process Wastewaters (Continued, Page 6 of 6)

CHLORINATED ETHANES AND ETHYLENES

TRICHLOROETHYLENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND*	(1)	NA
1	0.052*	(1)	1.8
1	0.052*	(1)	1.8

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

TETRACHLOROETHYLENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.37*	(1)	1.8
2	<98.0	(6)	0.00185
1	0.467*	(3)	0.1893
2	0.467*	(3)	0.1893

* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-18. Nitrosamines Indicated to be Present in Pesticide Process Wastewaters

Pesticide Produced	PRIORITY POLLUTANT NITROSAMINE	
	N-Nitrosodimethylamine	N-Nitrosodi-n-propylamine
AA	—	B
BB	B	B

B = Reaction byproduct.

Table V-19. Nitrosamines Detected in Pesticide Process Wastewaters

PRIORITY POLLUTANT NITROSAMINE

N-NITROSODIMETHYLAMINE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.00005	(240)	0.352

(n) = Number of data points.

N-NITROSODI-N-PROPYLAMINE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.069	(592)	0.076
2	0.123	(360)	0.352
3	1.85	(3)	0.0678

(n) = Number of data points.

N-NITROSODIPHENYLAMINE

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

Table V-20. Phthalate Indicated to be Present in Pesticide Process Wastewaters

Pesticide Process	PRIORITY POLLUTANT PHTHALATE Dimethyl phthalate
AA	R
BB	B
CC	R

R = Raw material.
I = Raw material impurity.
B = Reaction byproduct.

Table V-21. Phthalate Esters Detected in Pesticide Process Wastewate

PRIORITY POLLUTANT PHTHALATE

DIMETHYL PHTHALATE

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

DIETHYL PHTHALATE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND*	(1)	1.8

ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-21. Phthalate Esters Detected in Pesticide Process Wastewate
(Continued, Page 2 of 2)

PRIORITY POLLUTANT PHTHALATE

DI-N-BUTYL PHTHALATE

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

BUTYL BENZYL PHTHALATE

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

BIS(2-ETHYLHEXYL) PHTHALATE

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

Table V-22. Dichloropropane and Dichloropropene Indicated to be Present in Pesticide Process Wastewaters

Pesticide Process	PRIORITY POLLUTANT	
	1,2-Dichloropropane	1,3-Dichloropropene
A	I	I
B	P	P
C	B	P
D	I	R
E	—	I
F	I	--
G	I	I
H	—	I

P = Product.
R = Raw material.
I = Raw material impurity.
S = Solvent.
IS = Solvent impurity.
B = Reaction byproduct.
— = Not suspected.

Table V-23. Dichloropropane and Dichloropropene Detected in Pesticide Process Wastewaters

PRIORITY POLLUTANT

1,2-DICHLOROPROPANE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND*	(1)	NA

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

1,3-DICHLOROPROPENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND*	(1)	NA
2	ND*	(1)	NA

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-24. Priority Pollutant Pesticides Indicated to be Present in Pesticide Process Wastewaters

Pesticide Produced	PRIORITY POLLUTANT PESTICIDE											
	Aldrin	Dieldrin	Endo-sulfan's*	Endo-sulfan Sulfate	Endrin	Endrin aldehyde	Heptachlor	Heptachlor epoxide	BHC's*	DDT,DDD, DDE	Chlordane	Toxaphene
A	--	--	--	--	--	--	--	--	P,B	--	--	--
B	--	--	--	--	--	--	B	B	--	--	P	--
C	--	--	--	--	--	--	--	--	--	B,P,B	--	--
D	--	--	--	--	--	--	--	--	--	B,B,P	--	--
E	--	--	--	--	--	--	--	--	--	P,B,B	--	--
F	--	--	--	--	--	--	--	--	--	R,B,B	--	--
G	--	--	P	B	--	--	--	--	--	--	--	--
H	B	B	--	--	P	B	--	--	--	--	--	--
I	--	--	--	--	--	--	P	B	--	--	B	--
J	--	--	--	--	--	--	--	--	P,B	--	--	--
K	--	--	--	--	--	--	--	--	--	--	--	P

R = Raw material.
P = Product.
B = Reaction byproduct.
-- = Not suspected.
* = All isomers.
† = Alpha, beta and delta isomers

Table V-25. Priority Pollutant Pesticides Detected in Pesticide Process Wastewaters

PRIORITY POLLUTANT PESTICIDE

ALDRIN

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.012*	(3)	0.1893

---

* = Data from comingled pesticide streams.
(n) = Number of data points.

DIELDRIN

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.382*	(3)	0.1893

---

* = Data from comingled pesticide streams.
(n) = Number of data points.

ENDOSULFANS--ALL ISOMERS

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

Table V-25. Priority Pollutant Pesticides Detected in Pesticide Process Wastewaters (Continued, Page 2 of 5)

PRIORITY POLLUTANT PESTICIDE

ENDOSULFAN SULFATE

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

- -

ENDRIN

Plant	Conc. mg/l	(n)	Flow (MGD)
1	<0.510	(171)	0.184
2	0.518	(3)	0.1893

- -

(n) = Number of data points.

Table V-25. Priority Pollutant Pesticides Detected in Pesticide Process Wastewaters (Continued, Page 3 of 5)

PRIORITY POLLUTANT PESTICIDE

ENDRIN ALDEHYDE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND*	(1)	NA

NA = Not analyzed.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

HEPTACHLOR

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.095	(3)	0.1893
2	0.320	(184)	0.184

(n) = Number of data points.

HEPTACHLOR EPOXIDE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND*	(1)	NA

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-25. Priority Pollutant Pesticides Detected in Pesticide Process Wastewaters (Continued, Page 4 of 5)

PRIORITY POLLUTANT PESTICIDE

BHCs--ALPHA, BETA, AND DELTA ISOMERS

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

4,4'-DDD

Plant	Conc. mg/l	(n)	Flow (MGD)
1	<1.54	(16)	NA

NA = Not available.
* = Not presently manufactured.
(n) = Number of data points.

4,4'-DDE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	7.34	(16)	NA
2	174	(1)	0.0163

NA = Not available.
* = Not presently manufactured.
(n) = Number of data points.

Table V-25. Priority Pollutant Pesticides Detected in Pesticide Process Wastewaters (Continued, Page 5 of 5)

PRIORITY POLLUTANT PESTICIDE

4,4'-DDT

Plant	Conc. mg/l	(n)	Flow (MGD)
1	<0.20	(16)	NA
2	135	(1)	0.0163

NA = Not available.
* = Not presently manufactured.
(n) = Number of data points.

CHLORDANE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND*	(1)	NA

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide stream.
(n) = Number of data points.

TOXAPHENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.065	(4)	1.22
2	5.32	(3)	0.0717

= Analysis not conducted per protocol.
(n) = Number of data points.

Table V-26. Dienes Indicated to be Present in Pesticide Process Wastewaters

Pesticide Process	PRIORITY POLLUTANT	
	HCCPD	Hexachlorobutadiene
AA	R	B
BB	R	B
CC	R	B
DD	R	B
EE	R	B
FF	R	B,S

S = Solvent.
R = Raw material.
B = Raw material synthesis byproduct.
HCCPD = Hexachlorocyclopentadiene.

Table V-27. Dienes Detected in Pesticide Process Wastewaters

PRIORITY POLLUTANT

HEXACHLOROCYCLOPENTADIENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	Trace	(1)	0.000946
2	180	(1)	0.001
1	2,500	(2)	0.10
1	0.435*	(50)	0.184
2	0.435*	(50)	0.184
3	0.827*	(3)	0.1893
4	0.827*	(3)	0.1893

---

* = Data from comingled pesticide streams.
= Data exceed published solubility of compound in water apparentl due to sampling from organic, nonaqueous streams.
= Attributed to intermediate.
(n) = Number of data points.

HEXACHLOROBUTADIENE

Plant	Conc. mg/l	(n)	Flow (MGD)
1	0.191*	(3)	0.1893
2	0.191*	(3)	0.1893

---

* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-28. TCDD Indicated to be Present in Pesticide Process Wastewaters

Pesticide Process	Raw Material	PRIORITY POLLUTANT TCDD
AA	2,4,5-Trichlorophenol	B
BB	1,2,4,5-Tetrachlorobenzene	B
CC	1,2,4,5-Tetrachlorobenzene	B
DD	2,4,5-Trichlorophenol	B
EE	2,4,5-Trichlorophenol	B

TCDD = 2,3,7,8-Tetrachlorodibenzo-p-dioxin.
B = Reaction byproduct.

Table V-29. TCDD Detected in Pesticide Process Wastewaters

PRIORITY POLLUTANT

2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND	(E)	0.0031
1	<0.000002*	(3)	0.20
2	<0.000002*	(3)	0.20
3	<0.000002*	(3)	0.20
4	0.022*	(1)	0.20
5	0.022*	(1)	0.20
6	0.022*	(1)	0.20

ND = Not detected.
* = Data from comingled pesticide streams.
(E) = Estimate.
(n) = Number of data points.

Table V-30. Asbestos Detected in Pesticide Process Wastewaters

PRIORITY POLLUTANT ASBESTOS

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND*	(1)	0.900
2	ND*	(1)	8.00
3	ND*	(1)	8.00
4	ND*	(1)	0.030
5	ND*	(1)	8.00
6	ND*	(1)	8.00
7	0.000038*	(1)	NA
8	0.000038*	(1)	NA
9	0.0003*	(1)	0.187
1	0.000824*	(1)	1.739
1	0.000824*	(1)	1.739
12	0.0027*	(1)	NA
13	0.049*	(1)	33.5
14	0.049*	(1)	33.5
1	ND*	(1)	8.00
2	ND*	(1)	0.960
3	ND*	(1)	8.00
4	ND*	(1)	0.036
5	ND*	(1)	8.00
6	ND*	(1)	0.080
7	ND*	(1)	0.080
8	ND*	(1)	8.00
9	ND*	(1)	0.960
10	0.000038*	(1)	NA
11	0.000185*	(1)	0.030
12	0.0003*	(1)	0.187
13	0.000824*	(1)	1.739
14	0.0027*	(1)	NA
15	0.0027*	(1)	NA
16	0.0027*	(1)	NA
17	0.003*	(1)	0.187
18	0.049*	(1)	33.5
19	0.049*	(1)	33.5
20	0.049*	(1)	33.5
21	0.049*	(1)	33.5
22	0.049*	(1)	33.5

- -

Footnotes at end of table

Table V-30. Asbestos Detected in Pesticide Process Wastewaters (Continued, Page 2 of 3)

PRIORITY POLLUTANT ASBESTOS

Plant	Conc. mg/l	(n)	Flow (MGD)
23	0.049*	(1)	33.5
24	0.049*	(1)	33.5
25	0.049*	(1)	33.5
26	0.049*	(1)	33.5
27	0.049*	(1)	33.5
28	0.049*	(1)	33.5
29	0.049*	(1)	33.5
30	0.049*	(1)	33.5
31	0.3*	(1)	0.100
32	0.3*	(1)	0.100
33	0.3*	(1)	0.100
34	0.3*	(1)	0.100
35	0.3*	(1)	0.100
36	0.3*	(1)	0.100
1	0.0027*	(1)	NA
1	ND*	(1)	0.960
1	0.000038*	(1)	NA
2	0.000038*	(1)	NA
3	0.000038*	(1)	NA
1	ND*	(1)	0.900
2	ND*	(1)	8.00
1	ND*	(1)	0.080
3	ND*	(1)	0.036
4	ND*	(1)	0.083
5	0.00093*	(1)	1.90
6	0.00093*	(1)	1.90
7	0.0027*	(1)	NA
8	0.0027*	(1)	NA
9	0.049*	(1)	33.5

Footnotes at end of table

Table V-30. Asbestos Detected in Pesticide Process Wastewaters (Continued, Page 3 of 3)

PRIORITY POLLUTANT ASBESTOS

Plant	Conc. mg/l	(n)	Flow (MGD)
10	0.049*	(1)	33.5
11	0.049*	(1)	33.5
12	0.3*	(1)	0.100
13	0.3*	(1)	0.100
14	0.3*	(1)	0.100
1	ND*	(1)	0.960
2	ND*	(1)	0.900
3	ND*	(1)	0.960
4	ND*	(1)	0.960
5	ND*	(1)	0.960
6	ND*	(1)	0.960
7	ND*	(1)	0.960
8	ND*	(1)	0.960
9	ND*	(1)	0.960
10	ND*	(1)	0.960
11	0.0003*	(1)	0.187

NA = Not available.
ND = Not detected.
* = Data from comingled wastewater.
= Total calculated mass chrysotile fibers only. Maximum of all plant averages reported.
(n) = Number of data points.

Table V-31. Nonconventional Parameters Detected in Pesticide Process Wastewaters

NONCONVENTIONAL PARAMETERS

PESTICIDES

Plant	Conc. mg/l	(n)	Flow (MGD)
1	ND*	(11)	0.405
2	ND	(1)	0.000002
3	ND	(E)	0.00005
4	None	(E)	0.0048
5	None	(E)	0.0048
6	None	(E)	0.0004
7	0.003	(1)	0.101
8	<0.0336	(25)	1.8
9	1.60	(8)	1.15
10	3.32*	(3)	1.88
11	3.49	(10)	NA
12	7.57	(5)	0.0315
13	8.03*	(18)	0.0923
14	10.4	(221)	1.08
15	10.9	(4)	1.224
16	16.0**	(1)	0.03
17	41.8	(147)	0.242
18	160	(3)	0.00323
19	430	(3)	0.187
20	477	(163)	0.006
21	720	(1)	0.01
22	747	(1)	0.0451
23	1,090	(2)	0.0072
24	3,000	(E)	0.022
25	4,320	(150)	0.005
26	5,995	(E)	0.00020
27	6,478	(1)	0.00281
28	6,800	(1)	0.0034
29	11,200	(690)	0.005
1	NA	(180)	0.012
2	ND	(1)	0.000002
3	0.000953	(29)	0.8

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
= Analyzed as hydrolysis product.
** = Average of pilot plant data.
(E) = Estimate.
(n) = Number of data points.

Table V-31. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 2 of 11)

NONCONVENTIONAL PARAMETERS

PESTICIDES

Plant	Conc. mg/l	(n)	Flow (MGD)
4	<0.019	(10)	1.8
5	<0.0817	(105)	1.8
6	<0.0918	(33)	1.8
7	<0.159	(7)	1.8
8	0.175	(2)	0.00854
9	<0.189	(18)	1.8
10	0.207	(2)	2.3
11	0.240	(4)	28.2
12	0.439	(20)	1.8
13	0.470	(3)	28.2
14	0.527	(8)	0.130
15	0.58	(4)	0.09425
16	0.615	(3)	1.241
17	0.70	(11)	3.6
18	<0.850	(59)	1.8
19	1.08	(1)	0.144
20	1.10	(3)	28.2
21	1.54	(6)	3.6
22	2.00	(E)	0.161
23	2.5	(9)	3.6
24	3.0	(3)	28.2
25	4.26	(365)	1.034
26	6.30	(173)	0.104
27	7.75	(1)	0.0202
28	9.0	(22)	0.00156
29	13.2	(365)	1.034
30	14.4	(89)	1.034
31	15.0	(2)	0.012
32	17.0	(449)	0.135
33	19.9	(3)	2.3
34	25.8*	(2)	0.0749
35	29.1	(1)	0.144
36	30.3	(30)	0.0792

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* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(E) = Estimate.
(n) = Number of data points.

Table V-31. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 3 of 11)

NONCONVENTIONAL PARAMETERS

PESTICIDES

Plant	Conc. mg/l	(n)	Flow (MGD)
37	36*	(47)	0.094
38	45.9	(3)	1.241
39	53.8	(2)	0.0086
40	71.1	(125)	0.08026
41	85*	(111)	0.094
42	93.1	(11)	0.08026
43	104	(570)	0.0634
44	127*	(111)	0.094
45	135*	(111)	0.094
46	136	(30)	0.2088
47	<152	(150)	0.08026
48	174	(173)	0.104
49	212	(1)	0.145
50	218	(5)	0.0315
51	260	(2)	0.022
52	300	(1)	0.30
53	320	(13)	0.208
54	335	(3)	0.154
55	600	(E)	4,140 gal/ 1,000 lbs
56	863*	(1)	0.144
57	863*	(1)	0.144
58	863*	(1)	0.144
59	863*	(1)	0.144
60	863*	(1)	0.144
61	973	(30)	0.792
62	1,100	(474)	0.1633
63	1,290	(12)	0.163
64	1,630	(180)	0.012
65	1,778	(5)	NA
66	2,600	(1)	0.0086
67	3,460	(3)	0.0181
68	3,586	(2)	0.00125
69	4,580	(210)	0.008
70	5,500*	(1)	0.00002
71	5,500*	(1)	0.00002

NA = Not available.
* = Data from comingled pesticide streams.
= Values reported are after pretreatment.
(E) = Estimate.
(n) = Number of data points.

Table V-31. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 4 of 11)

NONCONVENTIONAL PARAMETERS

PESTICIDES

Plant	Conc. mg/l	(n)	Flow (MGD)
1	6.9	(13)	3.6
2	6.9	(E)	3.6
3	481	(E)	9,150 gal/ 1,000 lbs
1	12.2	(7)	1.23
2	<23.5	(72)	1.42
3	60.0	(1)	1.5
4	<1,418	(4)	0.10
1	Trace	(1)	0.000946
2	<0.820	(23)	1.8
3	25.8*	(2)	0.0749
4	25.8*	(2)	0.0749
5	863*	(1)	0.144
1	12.2*	(606)	0.75
2	12.2*	(606)	0.75
3	14.8	(3)	0.0678
4	26.8	(14)	0.06
5	27	(85)	0.05
6	184	(26)	0.081
7	5,950	(690)	0.010
1	0.00846	(3)	1.241
2	<0.010	(3)	0.1027
3	0.065	(4)	1.224
4	0.095	(3)	0.1893
5	0.2	(4)	28.2
6	0.320	(184)	0.184
7	0.457	(2)	0.0033
8	<0.510	(171)	0.184
9	0.518	(3)	0.1893
10	<0.753	(120)	1.8
11	1.48	(3)	2.3

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* = Data from comingled pesticide streams.
  = Analysis not conducted per protocol.
(E) = Estimate.
(n) = Number of data points.

Table V-31. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 5 of 11)

NONCONVENTIONAL PARAMETERS

PESTICIDES

Plant	Conc. mg/l	(n)	Flow (MGD)
12	<2.00	(1)	2.3
13	<3.02	(75)	1.8
14	5.32	(3)	0.0717
15	15.5	(25)	505 gal/ 1,000 lbs
16	17.2	(17)	117 gal/ 1,000 lbs
17	32.3	(1)	0.20
18	49.7	(1)	0.20
19	66.5	(1)	0.20
20	82.5	(28)	0.138
21	83.0	(3)	0.120
22	190	(2)	0.0163
23	228	(2)	0.0163
24	326	(1)	0.042
25	330	(3)	0.3283
26	535	(30)	0.101
27	9,300	(3)	0.015
1	<0.01	(26)	1.8
2	<3.58	(80)	1.8
3	<4.93	(49)	1.42
4	<6.32	(28)	1.42
5	<6.64	(22)	1.42
6	<7.67	(9)	1.42
7	<8.51	(41)	1.42
8	<15.8	(28)	1.42
9	<17.7	(87)	1.42
10	18.1	(4)	1.224
11	40.7	(154)	1.01
12	45.7*	(540)	2.5
13	45.7*	(540)	2.5
14	45.7*	(540)	2.5
15	83.4	(3)	0.0634
16	133*	(270)	1.3
17	133*	(270)	1.3
18	133*	(270)	1.3

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* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-31. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 6 of 11)

NONCONVENTIONAL PARAMETERS

COD

Plant	Conc. mg/l	(n)	Flow (MGD)
1	<100.0 **	(1)	NA
2	431*	(3)	0.110
3	895*	(3)	1.22
4	2,750	(3)	1.88
5	2,750	(3)	1.88
6	2,830	(1)	2.01
7	2,830	(1)	2.01
8	4,500 **	(1)	NA
9	4,750*	(5)	0.0315
10	5,800	(8)	0.106
11	7,070*	(59)	1,900 gal/ 1,000 lbs
12	8,120	(E)	1,200 gal/ 1,000 lbs
13	14,400	(1)	0.0013
14	17,000*	(E)	0.02
15	17,000*	(E)	0.02
16	17,000*	(E)	0.02
17	18,900*	(12)	0.105
18	22,650	(1)	0.0034
19	23,900	(E)	774 gal/ 1,000 lbs
20	150,000	(1)	0.018
21	150,000	(1)	0.018
22	1,220,000	(E)	156 gal/ 1,000 lbs
1	14.0*	(1)	NA
2	14.0*	(1)	NA
3	360	(449)	0.135
4	431*	(3)	0.110
5	711*	(E)	8,000 gal/ 1,000 lbs
6	711*	(E)	8,000 gal/ 1,000 lbs

NA = Not available.
* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
** = Pilot plant data average.
(E) = Estimate.
(n) = Number of data points.

Table V-31. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 7 of 11)

NONCONVENTIONAL PARAMETERS

COD

Plant	Conc. mg/l	(n)	Flow (MGD)
7	711*	(E)	8,000 gal/ 1,000 lbs
8	1,318*	(365)	1.034
9	1,318*	(365)	1.034
10	1,320*	(365)	1.034
11	1,660	(3)	2.3
12	1,660	(3)	2.3
13	1,660	(3)	2.3
14	1,710	NA	0.2088
15	2,190	(421)	0.124
16	2,450	(1)	0.018
17	3,340*	(3)	0.1027
18	3,710	(30)	0.792
19	4,750*	(5)	0.0315
20	4,900	(1)	0.010
21	5,250	(1)	0.09
22	5,250	(73)	0.1633
23	5,700	NA	0.0792
24	5,870	(3)	1.241
25	5,870	(3)	1.241
26	7,070*	(59)	1,900 gal/ 1,000 lbs
27	7,070*	(59)	1,900 gal/ 1,000 lbs
28	7,070*	(59)	1,900 gal/ 1,000 lbs
29	7,070*	(59)	1,900 gal/ 1,000 lbs
30	14,000	(3)	0.048
31	16,000	(E)	1,200 gal/ 1,000 lbs
32	16,800	NA	0.0634
33	28,000	(3)	0.0181
34	40,000	(1)	0.30

NA = Not available.
* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(E) = Estimate.
(n) = Number of data points.

Table V-31. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 8 of 11)

NONCONVENTIONAL PARAMETERS

COD

Plant	Conc. mg/l	(n)	Flow (MGD)
35	75,500	(1)	0.0202
36	150,000	(1)	0.018
37	150,000	(1)	0.018
38	195,000	(E)	4,718 gal/ 1,000 lbs
1	1,570	(E)	9,150 gal/ 1,000 lbs
1	17,000*	(E)	0.02
1	7,070*	(59)	1,900 gal/ 1,000 lbs
1	436*	(606)	0.7224
2	436*	(606)	0.7224
3	5,109	(3)	0.0678
4	9,740	(375)	0.213
5	150,000	(1)	0.018
1	594	(3)	0.0717
2	674*	(3)	0.1893
3	674*	(3)	0.1893
4	1,610	(3)	0.0033
5	1,660	(3)	2.3
6	3,340*	(3)	0.1027
7	3,340*	(3)	0.1027
8	5,870	(3)	1.241
9	7,070*	(59)	1,900 gal/ 1,000 lbs
10	7,070*	(59)	1,900 gal/ 1,000 lbs
11	18,900*	(12)	0.105
12	148,000	(6)	117 gal 1,000 lbs

NA = Not available.
* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(E) = Estimate.
(n) = Number of data points.

Table V-31. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 9 of 11)

NONCONVENTIONAL PARAMETERS

COD

Plant	Conc. mg/l	(n)	Flow (MGD)
1	353*	(270)	1.3
2	353*	(270)	1.3
3	353*	(270)	1.3
4	468*	(540)	2.5
5	468*	(540)	2.5
6	468*	(540)	2.5
7	895*	(3)	1.22
8	5,870	(3)	1.241
9	17,444	(1)	0.0634

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* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-31. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 10 of 11)

NONCONVENTIONAL PARAMETERS

TOC

Plant	Conc. mg/l	(n)	Flow (MGD)
1	900	(1)	2.01
2	900	(1)	2.01
3	1,650*	(5)	0.0315
4	4,420	(3)	1.88
5	4,420	(3)	1.88
6	5,850*	(12)	0.105
7	11,400	(19)	0.01
8	50,000	(1)	0.018
9	50,000	(1)	0.018
1	122*	(47)	0.551
2	1,650*	(5)	0.0315
3	1,810	(3)	1.241
4	1,810	(3)	1.241
5	3,230	(503)	0.1633
6	19,500	(1)	0.0202
7	28,500	(3)	0.0181
8	50,000	(1)	0.018
9	50,000	(1)	0.018
1	122*	(47)	0.551
2	523*	(469)	0.15
1	50,000	(1)	0.018
1	53.2	(3)	0.0717
2	341*	(3)	0.1893
3	341*	(3)	0.1893
4	441	(3)	0.0033
5	1,810	(3)	1.241
6	2,660*	(3)	0.243
7	5,850*	(12)	0.105
8	79,800	(6)	117 gal/ 1,000 lbs

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* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-31. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 11 of 11)

NONCONVENTIONAL PARAMETERS

TOC

Plant	Conc. mg/l	(n)	Flow (MGD)
1	178*	(540)	2.5
2	178*	(540)	2.5
3	178*	(540)	2.5
4	585*	(270)	1.3
5	585*	(270)	1.3
6	585*	(270)	1.3
7	1,810	(3)	1.241

* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(n) = Number of data points.

TOD

Plant	Conc. mg/l	(n)	Flow (MGD)

No data available.

Table V-32. Conventional Parameters Detected in Pesticide Process Wastewaters

CONVENTIONAL PARAMETERS

BOD

Plant	Conc. mg/l	(n)	Flow (MGD)
1	<103	(3)	0.00323
2	103*	(3)	0.110
3	120	(3)	28.2
4	137*	(3)	1.22
5	572	(8)	0.106
6	791	(2)	1.88
7	791	(2)	1.88
8	2,000 **	(1)	NA
9	2,260*	(14)	1,900 gal/ 1,000 lbs
10	2,450	(E)	1,200 gal/ 1,000 lbs
11	3,490	(1)	0.0034
12	6,600*	(12)	0.105
13	16,000	(1)	0.0013
14	60,000	(1)	0.018
15	60,000	(1)	0.018
1	103*	(3)	0.110
2	120	(3)	28.2
3	120	(3)	28.2
4	120	(3)	28.2
5	120	(3)	28.2
6	120	(3)	28.2
7	120	(3)	28.2
8	120	(3)	28.2
9	179*	(41)	0.551
10	355*	(E)	8,000 gal/ 1,000 lbs
11	355*	(E)	8,000 gal/ 1,000 lbs
12	355*	(E)	8,000 gal/ 1,000 lbs
13	610	(4)	2.3

NA = Not available.
* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
** = Pilot plant data average.
(E) = Estimate.
(n) = Number of data points.

Table V-32. Conventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 2 of 7)

CONVENTIONAL PARAMETERS

BOD

Plant	Conc. mg/l	(n)	Flow (MGD)
14	610	(4)	2.3
15	610	(4)	2.3
16	630*	(202)	1.034
17	630*	(202)	1.034
18	630*	(202)	1.034
19	1,000	(1)	0.018
20	1,940	(3)	1.241
21	1,940	(3)	1.241
22	2,000	(1)	0.010
23	2,260*	(14)	1,900 gal/ 1,000 lbs
24	2,260*	(14)	1,900 gal/ 1,000 lbs
25	2,260*	(14)	1,900 gal/ 1,000 lbs
26	2,260*	(14)	1,900 gal/ 1,000 lbs
27	3,330	(2)	0.0181
28	3,500	(1)	0.30
29	4,840	(E)	4,140 gal/ 1,000 lbs
30	5,680*	(3)	0.1027
31	7,200	(3)	0.048
32	8,500	(E)	1,200 gal/ 1,000 lbs
33	19,600	(E)	4,140 gal/ 1,000 lbs
34	60,000	(1)	0.018
35	60,000	(1)	0.018
1	703	(E)	9,150 gal/ 1,000 lbs

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* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
= Values reported are after pretreatment.
(E) = Estimate.
(n) = Number of data points.

Table V-32. Conventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 3 of 7)

CONVENTIONAL PARAMETERS

BOD

Plant	Conc. mg/l	(n)	Flow (MGD)
1	179*	(41)	0.551
2	2,082	(756)	1.42
1	2,260*	(14)	1,900 gal/ 1,000 lbs
1	4,320	(85)	0.213
2	60,000	(1)	0.018
1	58.2	(3)	0.0717
2	120	(3)	28.2
3	331*	(3)	0.1893
4	331*	(3)	0.1893
5	610	(4)	2.3
6	1,940	(3)	0.084
7	1,940	(3)	1.241
8	2,260*	(14)	1,900 gal/ 1,000 lbs
9	2,260*	(14)	1,900 gal/ 1,000 lbs
10	5,680*	(3)	0.1027
11	5,680*	(3)	0.1027
12	6,600*	(12)	0.105
13	45,200	(6)	117 gal/ 1,000 lbs
1	ND*	(270)	1.3
2	ND*	(270)	1.3
3	ND*	(270)	1.3
4	137*	(3)	1.22
5	300	(1)	0.0634
6	1,940	(3)	1.241
7	2,082	(756)	1.42
8	2,082	(756)	1.42
9	2,082	(756)	1.42

ND = Not detected.
* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-32. Conventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 4 of 7)

CONVENTIONAL PARAMETERS

BOD

Plant	Conc. mg/l	(n)	Flow (MGD)
10	2,082	(756)	1.42
11	2,082	(756)	1.42
12	2,082	(756)	1.42
13	2,082	(756)	1.42

= Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-32. Conventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 5 of 7)

CONVENTIONAL PARAMETERS

TSS

Plant	Conc. mg/l	(n)	Flow (MGD)
1	59.0	(3)	28.2
2	69.0*	(3)	0.110
3	87.7	(3)	0.00323
4	110	(146)	0.242
5	143	(3)	1.88
6	143	(3)	1.88
7	181	(E)	1,200 gal/ 1,000 lbs
8	246*	(37)	1,900 gal/ 1,000 lbs
9	340	(1)	2.01
10	340	(1)	2.01
11	350	(8)	0.106
12	750	(1)	0.0034
1	2.00*	(1)	NA
2	2.00*	(1)	NA
3	3.00	(3)	2.3
4	3.00	(3)	2.3
5	3.00	(3)	2.3
6	32.8*	(365)	1.034
7	32.8*	(365)	1.034
8	32.8*	(365)	1.034
9	37.3	NA	0.2088
10	68.6*	(5)	0.0315
11	56.6*	(3)	0.1027
12	59.0	(3)	28.2
13	59.0	(3)	28.2
14	59.0	(3)	28.2
15	59.0	(3)	28.2
16	59.0	(3)	28.2
17	59.0	(3)	28.2
18	59.0	(3)	28.2

NA = Not available.
* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
= Values reported are after pretreatment.
(E) = Estimate.
(n) = Number of data points.

Table V-32. Conventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 6 of 7)

CONVENTIONAL PARAMETERS

TSS

Plant	Conc. mg/l	(n)	Flow (MGD)
19	69.0*	(3)	0.110
20	78.0	(30)	0.792
21	100	(1)	0.010
22	124	(1)	0.0792
23	246*	(37)	1,900 gal/ 1,000 lbs
24	246*	(37)	1,900 gal/ 1,000 lbs
25	246*	(37)	1,900 gal/ 1,000 lbs
26	246*	(37)	1,900 gal/ 1,000 lbs
27	269	(3)	1.241
28	269	(3)	1.241
29	300	(1)	0.018
30	3,000	(1)	0.0202
31	3,800*	(E)	8,000 gal/ 1,000 lbs
32	3,800*	(E)	8,000 gal/ 1,000 lbs
33	3,800*	(E)	8,000 gal/ 1,000 lbs
34	4,090	(3)	0.0181
1	1,720	(E)	9,150 gal/ 1,000 lbs
1	375	(73)	1.42
1	246*	(37)	1,900 gal/ 1,000 lbs
1	141	(30)	0.352
2	360	(12)	1,510 gal/ 1,000 lbs

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* = Data from comingled pesticide streams.
= Data from comingled pesticide/other product streams.
(E) = Estimate.
(n) = Number of data points.

Table V-32. Conventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 7 of 7)

CONVENTIONAL PARAMETERS

TSS

Plant	Conc. mg/l	(n)	Flow (MGD)
3	407	(1)	NA
1	3.00	(3)	2.3
2	56.6*	(3)	0.1027
3	56.6*	(3)	0.1027
4	59.0	(3)	28.2
5	208*	(3)	0.1893
6	208*	(3)	0.1893
7	226	(3)	0.0033
8	246*	(37)	1,900 gal/ 1,000 lbs
9	246*	(37)	1,900 gal/ 1,000 lbs
10	269	(3)	1.241
11	1,460	(6)	117 gal/ 1,000 lbs
12	2,720	(3)	0.0717
1	253*	(530)	2.5
2	253*	(530)	2.5
3	253*	(530)	2.5
4	269	(3)	1.241
5	375	(73)	1.42
6	375	(73)	1.42
7	375	(73)	1.42
8	375	(73)	1.42
9	375	(73)	1.42
10	375	(73)	1.42
11	375	(73)	1.42
12	411*	(270)	1.3
13	411*	(270)	1.3
14	411*	(270)	1.3
15	474	(1)	0.0634

NA = Not available.
= Data from comingled pesticide/other product streams.
* = Data from comingled pesticide streams.
= Post pretreatment.
(n) = Number of data points.

Table V-33. Summary of Raw Waste Load Design Levels

Pollutant Group	Design Level (mg/l)	Percent of Detected Pesticide Wastewaters at Design Level*
Volatile Aromatics	127-293,000	24
Halomethanes	122-2,600	23
Cyanides	5,503	6.0
Haloethers	0.582	17
Phenols	100-42,000	45
Nitro-Substituted Aromatics	ND	100
Polynuclear Aromatics	1.06-1.2	25
Metals--Copper	4,500	17
--Zinc	247	100
Chlorinated Ethanes & Ethylenes	98-10,000	18
Nitrosamines	1.96	100
Phthalates	ND	100
Dichloropropane & Dichloropropene	ND	100
Pesticides	10-11,200	45
Dienes	2,500-15,000	50
TCDD	0.022	100
Miscellaneous	N/A	N/A
PCBs	N/A	N/A
Benzidine	N/A	N/A
BOD	1,470	33
COD	3,886	45
TSS	266	14

N/A = Not applicable.
ND = Not detected.
* = Remainder of known pesticide wastewaters are below design level
= Prior to biological oxidation.

Table V-34. Plants Manufacturing Pesticides With No Process Wastewater Discharge*

Plant Code	Pesticide	Comment
1	2,4-D dimethyl amine salt	No Wastewater Generated
	2,4-D isooctyl ester	No Wastewater Generated
	Silvex dimethyl amine salt	No Wastewater Generated
	Silvex isooctyl ester	No Wastewater Generated
2	Pyrethrins	No Wastewater Generated
3	Ethoprop	Wastewater Evaporated
	Merphos	Wastewater Evaporated
4	Amobam	No Wastewater Generated
	Fluoroacetamide	No Wastewater Generated
	Sodium monofluoroacetate	No Wastewater Generated
5	Metasol J-26	No Wastewater Generated
6	Chloropicrin	Recycle/Reuse
7	Dichloroethyl ether	Wastewater Evaporated
	HPMTS	Wastewater Evaporated
8	Vancide 51Z	No Wastewater Generated
	Vancide 51Z dispersion	No Wastewater Generated
	Vancide TH	No Wastewater Generated
	Ziram	No Wastewater Generated
9	Glyodin	No Wastewater Generated
10	Dichlorophen salts	No Wastewater Generated
11	D-D	No Wastewater Generated
	Dichloropropene	No Wastewater Generated
12	D-D	Recycle/Reuse

Footnotes at end of table

Table V-34. Plants Manufacturing Pesticides With No Process Wastewater Discharge* (Continued, Page 2 of 2)

Plant Code	Pesticide	Comment
13	Barban	Wastewater Evaporated
14	Alkylamine hydrochloride	No Wastewater Generated
	BBTAC	No Wastewater Generated
	Tributyltin benzoate	No Wastewater Generated
15	Chloropicrin	Recycle/Reuse
16	Chloropicrin	Recycle/Reuse
	Dowicil 75	Wastewater Evaporated
17	D-D	No Wastewater Generated
	Dichloropropene	No Wastewater Generated
	Biphenyl	Wastewater Incinerated
18	Tributyltin oxide	No Wastewater Generated

* = "No process wastewater discharge" can be accomplished via recycle/reuse, evaporation, incineration, or if no wastewater is generated.

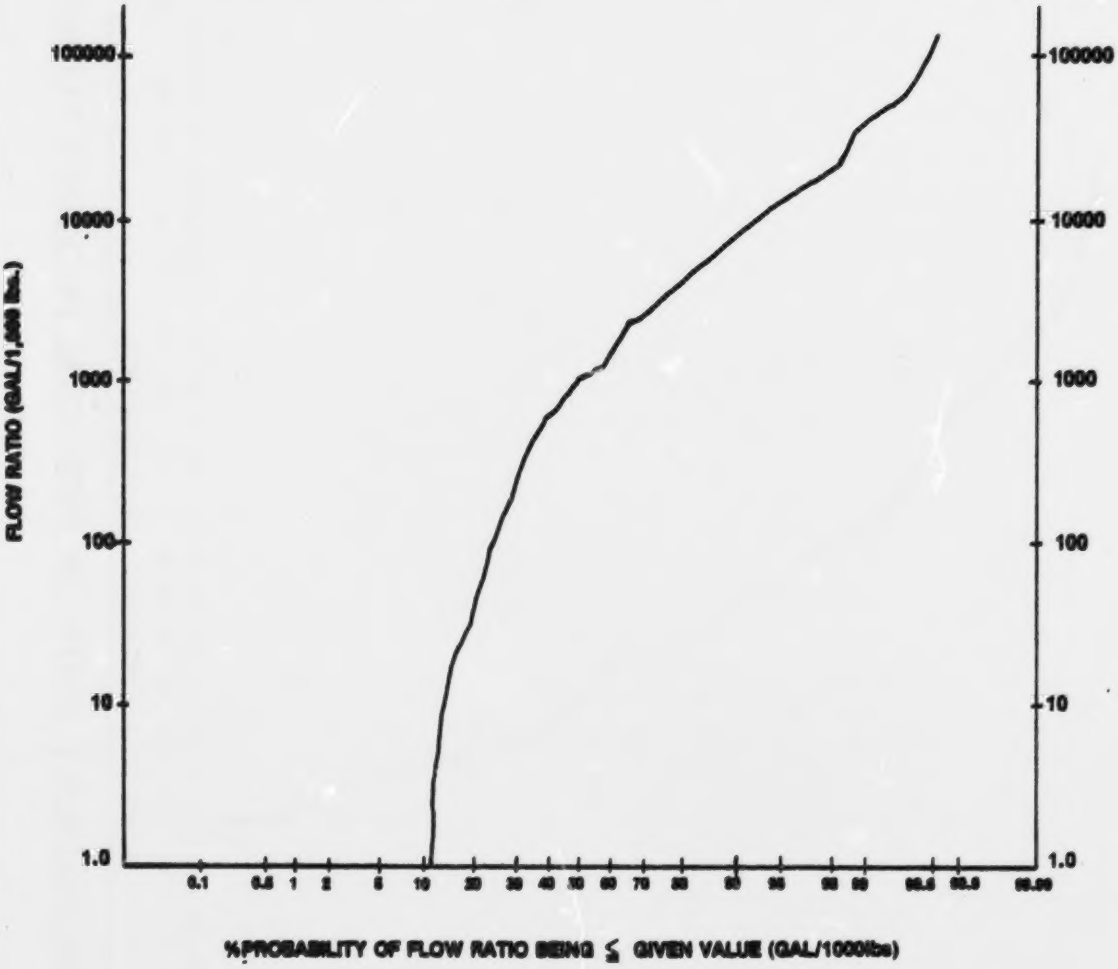

FIGURE V-1 PROBABILITY PLOT OF PESTICIDE PRODUCT FLOW RATIOS

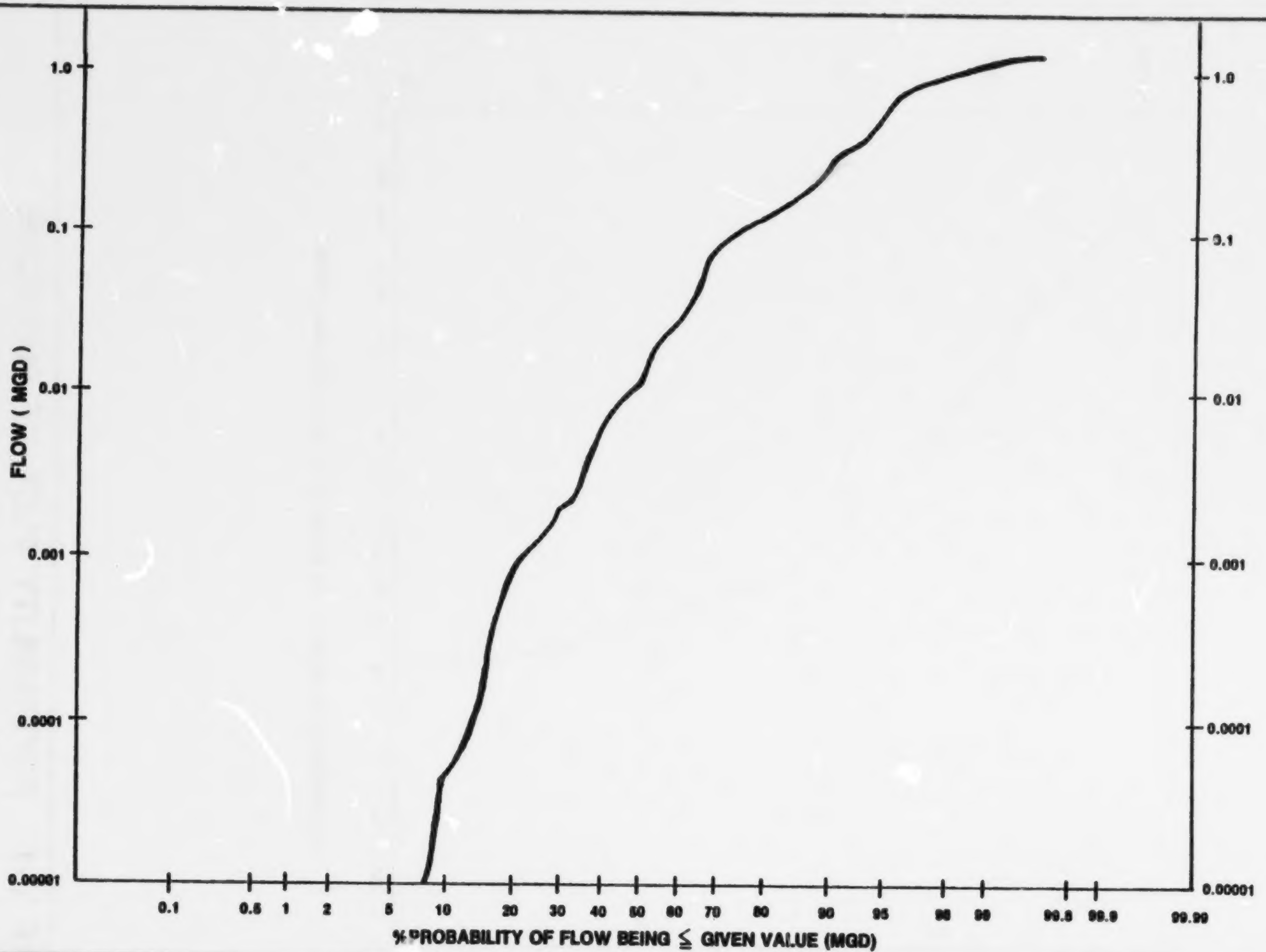

FIGURE V-2 PROBABILITY PLOT OF PESTICIDE PRODUCT FLOWS

SECTION VI

CONTROL AND TREATMENT TECHNOLOGY

INTRODUCTION

This section identifies the in-plant and end-of-pipe control and treatment technologies used for the removal of conventional, nonconventional, and priority pollutants by the pesticides industry. The effectiveness of potential technologies is evaluated, and recommended unit treatments are specified. Flow diagrams for the major unit treatments are also presented. The specific technologies selected as the basis for the regulation represent only one of several methods for the effective removal of the pollutants under consideration. Wastewater monitoring and treatability studies should be conducted for a particular facility in order to determine the most effective method for meeting these regulations. The design bases used in Section VIII primarily came from the full-scale treatment unit data as presented in this section. Therefore, the installation of similarly designed and properly operated systems is expected to result in the attainment of equivalent effluent levels. The major change from the proposed development document summary, based on public comment, is that the Agency is no longer using evaporation as the model technology for the formulator/packager subcategory because it is not effective in all situations. Instead, contract hauling and incineration and treatment with wastewater recycle are the model technologies for this subcategory.

As discussed in Section III much of the information provided by industry relates to proprietary products and processes. Therefore, pesticide names and associated data are coded in this report.

The data presented in this section is primarily from the data collection efforts undertaken prior to the November 1982 proposal. However, additional data were supplied as a result of the 1984 and 1985 NOAs. These data were primarily updates on the performance of treatment systems already included in this section.

The new data that were deemed "best performance" are included in the record and have been incorporated and presented in the development of limitations and standards sections of this document. The information in this section is representative of the combined data received.

BACKGROUND AND OPTIONS

On November 30, 1982, EPA proposed BAT, NSPS, PSES and PSNS effluent limitations and standards for the pesticide industry. In each case, technology options were considered, and one option selected as the basis for this regulation. The options were as follows:

BAT

Option	Technologies	Selection Option
1	In-plant activated carbon In-plant hydrolysis Biological treatment	
2	Option (1) Plus steam stripping, chemical oxidation, and metals precipitation	X
3	Option 2 plus end-of-pipe multi-media filtration	
4	Option 3 plus end-of-pipe activated carbon	

NSPS

Option	Technologies	Selected options
1	BAT option 2	X
2	BAT option 3	
3	BAT option 4	

PSES and PSNS

Option	Technologies	Selected option
1	In-plant activated carbon In-plant hydrolysis In-plant steam stripping In-plant chemical oxidation In-plant metals precipitation(2)	X
2	Option 1 plus Biological treatment	X

Table VI-1A lists the pollutants that can be removed by the technologies outlined above. As can be seen by the technology options, the Agency has found that the primary treatment scheme used by organic pesticide chemicals manufacturers is selected in-plant controls for the removal of highly concentrated pollutants followed by biological treatment.

In some cases, further end-of-pipe or other site specific alternatives are used to further reduce effluent concentrations. These are the bases for more stringent options considered by the Agency.

Table VI-1B lists all of the principle wastewater treatment and disposal methods used by this industry. However, this final rule uses as its basis only the model technologies used in EPA's 1982 proposal, and reiterated in the June 1984 notice of new information. The following discussion presents descriptions of each of these technologies, their use in the industry, and performance data collected from full scale, pilot, and demonstration facilities, as well as treatability studies.

SOURCE CONTROL

Although source control is not necessary for meeting these regulations, their application can be extremely effective in reducing the costs for in-plant controls and end-of-pipe treatment, and in some cases can eliminate the need for some treatment units entirely. The first and most cost-effective step which can be taken to reduce wastewater pollutant discharge is to control them at the source. The following discussion addresses some techniques which have general application throughout the industry.

Waste segregation is an important step in waste reduction. Process wastewaters containing specific pollutants can often be isolated and disposed of or treated separately in a more technically efficient, and economical manner. Highly acidic and caustic wastewaters are usually more effectively adjusted for pH prior to being mixed with other wastes. Separate equalization for streams of highly variable characteristics is utilized by more than 41 plants to improve overall treatment efficiency.

Water reduction can be achieved by replacing steam jet eductors and barometric condensors with vacuum pumps and surface condensers such as has been demonstrated by Plant 6. Reuse or recycle can be applied to reactor and floor washwater, surface runoff, scrubber effluents, and vacuum seal water as demonstrated by Plant 7. Reboilers can be used instead of live steam.

Good housekeeping procedures and wastewater monitoring programs can effect considerable water reductions and can prevent permit violations due to spills and leaks. Flow measuring devices and pH sensors with automatic alarms (such as at Plant 8), in order to detect process upsets, is just one of many ways to effect reductions in water use. Dry clean-up of spills can be used instead of washing spilled wastes into floor drains. This technique has been demonstrated to be effective in the formulation and packaging portion of the industry. Prompt repair and replacement of faulty equipment can also reduce wastewater losses.

Raw material recovery can be achieved through solvent extraction, steam stripping, and distillation operations as reported at Plants 9 and 10. Dilute streams can be concentrated in evaporators and then recovered. Water-based reactions can be conducted in solvents assuming that subsequent solvent recovery is practiced regularly.

Specific pollutants can be eliminated by requesting specification changes from raw material suppliers in cases where impurities are present and known to be discharged in process wastewaters.

TREATMENT TECHNOLOGIES IN-USE IN THE INDUSTRY

This section identifies the treatment technologies that were found to be applicable for the treatment of pesticides and priority pollutants in wastewaters generated by the pesticides industry. Figure VI-1 presents the range of flows for the various types of treatment used in the pesticides industry. As can be seen, most technologies are used over a wide range of flow conditions. As presented earlier, Table VI-1A lists thirteen treatment technologies currently utilized by the pesticides industry to remove various pollutant groups from process wastewaters. The primary unit treatment recommended for each pollutant group is designated with a "1". After treatment by the recommended primary unit, further removal is accomplished by follow-on treatment, which is designated with a "2".

Table VI-1B presents the number of plants currently using each of the technologies listed in Table VI-1A. It should be noted that many plants use more than one type of treatment technology to effect significant removals of pollutants.

Figures VI-2 through VI-10 provide schematic diagrams for the major treatment technologies discussed in this section.

In-Plant Controls

Table VI-IC lists those prioity pollutants and pesticides that can be removed by each of the 6 primary in-plant controls: steam stripping, activated carbon, resin adsorption, metals separation, chemical oxidation and hydrolysis. Steam stripping can remove volatile organic materials; activated carbon can remove semi-volatile organic compounds and many pesticides; and resin adsorption, chemical oxidation and hydrolysis can treat selected pesticides. Metals separation can treat those metals of concern to this industry. Each of these technologies are discussed in detail below.

Steam Stripping

Stripping operations involve passing a gas or vapor through a liquid with sufficient contact so that volatile components are transferred from liquid to the gas phase. The driving force for such an operation is the concentration differential between the liquid and concentrated equilibrium point of the gas. The transferred compound may then be recovered by condensing the stripping vapor. More complete separation of components may be obtained through refluxing of the stripped condensate. In the pesticide industry both steam and vacuum stripping have been demonstrated to be applicable to groups of priority pollutants such as volatile aromatics, halomethanes, and chloroethanes, as well as a variety of nonpriority pollutant compounds such as xylene, hexane, methanol, ethylamine, and ammonia.

Full-Scale Systems

Table VI-2 presents the design data for eight stripping systems used in the pesticide industry.

Plant 1 operates separate steam strippers for wastewater from the A, B, C, and D pesticide processes. The B pesticide stripper is designed primarily for the removal of methylene chloride (dichloromethane). The stripper contains 15 feet of packing containing 1 inch polypropylene saddles, to which is fed 8,000 pounds per hour wastewater and 1,860 pounds per hour steam. Stripped compounds are recycled to the process with a net economic savings being realized.

The stripper used for C and D pesticide wastewater at Plant 1 is operated for the removal of a nonpriority pollutant, xylene. The A pesticide process utilizes a vacuum stripper for the recovery of a nonpriority pollutant, isobutyl alcohol. No data are available to document the removal efficiency for xylene or isobutyl alcohol in the above mentioned systems.

Plant 2 operates a steam stripper to treat the combined wastewaters of Pesticides E, F, G, and other nonpesticide products. As shown in Table VI-3, the stripper removes chloroform and hexane to less than 5 mg/l at a removal rate of greater than 92.9 percent. Forty-five gallons per minute of wastewater is preheated before entering the 24-tray stripper comprising six theoretical units. The stripped compounds are disposed of by on-site incineration.

Plant 3 utilizes steam stripping treatment for wastewater from 10 of its pesticide processes. Methanol, toluene, and ethylene dichloride are stripped and recovered from wastewater when they are used in the process or as extraction solvents. No data are available to document the effectiveness of these individual pretreatment units since the plant would not participate in EPA verification sampling; however, no volatile organics have been detected over 1 mg/l in screening sampling of the combined raw waste load at this plant.

Plant 4 operates a steam stripper for the removal of ammonia and ethylamine from Pesticide R process wastewater. The process water enters the stripper at a flow of 0.072 MGD and approximately 100°C.

Plant 5 uses steam stripping for the removal of 1,2-dichloroethane from Pesticide S and Pesticide S intermediate process wastewaters. 1,2-Dichloroethane, a solvent used in the Pesticide S process, is recovered and recycled to the process.

Plant 6 operates a packed bed steam stripper for the removal of ammonia from Pesticide T process wastewater. Pesticide T wastewater enters the stripper at a temperature of 80°C and pH of 12 to enhance ammonia removal. Steam is added at a rate of

1,400 pounds per hour to the 0.0326-MGD stream. Stripper overheads containing ammonia, and organics are incinerated on-site.

Plant 7 uses steam stripping treatment for process wastewater from the U pesticide process. Methylene chloride is recovered from the steam stripper and recycled to the process. Stripped spent beer wastewater is pretreated and discharged to a POTW. No data are available to document the effectiveness of the steam stripper treatment system for the removal of methylene chloride.

Plant 8 operates a vacuum stripper for treatment of process wastewater from the V, W, and X pesticide processes. The original design was to remove toluene, used as an extractant solvent, from approximately 600 mg/l to less than 10 mg/l, while at the same time reducing the temperature of the process stream so as to improve resin adsorption effectiveness.

During 1980 an in-depth sampling and analytical program was conducted at three plants in the Organic Chemicals Industry which utilize steam stripping on wastewaters similar in nature to pesticide manufacturing plants. Data from these studies are presented as follows, with emphasis on those pollutants to be regulated in the Pesticide Industry. Plant A conducted more than 30 days of sampling on a steam stripper designed to remove nitrobenzene from process wastewater. Data showed that benzene, a pollutant to be regulated in the Pesticide Industry, was reduced from an influent of 15.4 mg/l to an effluent of 0.230 mg/l (98.5 percent removal efficieny).

Plant B conducted more than 40 days of sampling on a steam stripper designed to remove vinyl chloride from wastewater. Operating data for pollutants to be regulated in the Pesticide Industry were: 99.5 percent removal of methylene chloride, from 3.02 mg/l to 0.0141 mg/l; and 70.3 percent removal of toluene, from 178 mg/l to 52.8 mg/l.

Plant C conducted approximately 1 week of sampling at each of two strippers designed to remove chloroethane. Representative operating data for pollutants to be regulated in the Pesticide Industry were:

Compound	Influent (mg/l)	Stripper 1* Effluent (mg/l)	Percent Removal
Dichloromethane	1,430	0.0153	>99.99
Carbon tetrachloride	665	0.0549	>99.99
Chloroform	8.81	1.15	86.9

Compound	Influent (mg/l)	Stripper 2 Effluent (mg/l)	Percent Removal
Dichloromethane	4.73	0.0021	>99.95
Chloroform	18.6	1.9	89.8
1,2-Dichloroethane	36.2	4.36	88.0
Carbon tetrachloride	9.7	0.030	99.7
Benzene	24.1	0.042	>99.8
Toluene	22.3	0.091	>99.6

*=Preproposal Data

Additional sampling of steam stripping treatment in the Organic Chemicals Industry was conducted at Plant D's facility. Results for pollutants to be regulated in the Pesticide Industry were as follows:

Compound	Influent (mg/l)	Effluent (mg/l)	Percent Removal
Methylene chloride	34	0.01	>99.97
Chloroform	4,509	0.01	>99.99
1,2-Dichloroethane	9,030	0.01	>99.99

Data from one full scale steam stripper used in the pharmaceutical industry for the removal of methylene chloride was also obtained by the Agency. This stripper is used to treat solvent-bearing wastewaters from chemical synthesis operations, which are very similiar in nature to solvent-bearing wastewater in this industry. The stripper is a packed column, and is usually operated 12 hours per day, five days per week. The unit's average performance is as follows:

average influent, mg/l - 8,800

average effluent, mg/l - 6.9

average percent removal - 99.92

These data substantiate the high removal data presented earlier.

Treatability Studies--Coco, et al. (1978) evaluated the treatment of process effluents containing chlorinated hydrocarbons and aromatic hydrocarbons using steam stripping. This unit operation removed up to 99 percent of the chlorinated hydrocarbons (ethylene dichloride, which was the major organic component in the process effluent was consistently reduced from more than 1,000 mg/l in the stripper feed to less than 1 mg/l in the stripper bottoms) and up to 75 percent of the total organic carbon (TOC).

Hwang and Fahrenthold (1980) performed treatability evaluations to determine the extent to which organic priority pollutants can be steam stripped. Both mixture thermodynamics and tray efficiencies were considered in this evaluation. The results indicated that due to volatility and high activity coefficients of certain organic priority pollutants (see the list below), steam stripping is an effective means of removing these pollutants from wastewater. Based on a raw waste load solubility, and a column operating with aqueous reflux, the following effluent concentrations, tray requirements, and column efficiencies were predicted for priority pollutants to be regulated in the pesticide industry:

Compound	Effluent Concentration (ppb)	Number of Actual Trays Required	Column Efficiency (Percent)
Carbon tetrachloride	50	4	100
Chloroform	50	6	100
Methyl chloride	50	6	100
Methylene chloride	50	6	100
Bis(2-chloroethyl) ether	140	20	53
Benzene	50	5	100
Chlorobenzene	50	5	100
Toluene	50	5	98
1,3-Dichloropropene	50	5	100
1,2-Dichloroethane	50	6	100
Tetrachloroethylene	50	4	99
Methyl bromide	50	3	100
1,2-Dichlorobenzene	50	4	96
1,4-Dichlorobenzene	50	4	100
1,2,4-Trichlorobenzene	50	4	99

ESE (1975) conducted bench and pilot scale steam stripping studies at an ethyl benzene/styrene monomer chemicals plant. Benzene was reduced from 102 mg/l to 0.6 mg/l at optimum conditions; a full-scale system was designed to remove 99.4 percent of the aromatic hydrocarbons with a 2-foot diameter, and 18-foot-high column with 9 feet of packing for a flow of 30,000 gallons per day.

CHEMICAL OXIDATION

Oxidizing agents have been shown to be extremely effective for the removal of many complex organics from wastewater, including phenols, cyanide, selected pesticides such as ureas and uracils, COD, and organo-metallic complexes. The most widely used oxidants in the pesticide industry are chlorine and hydrogen peroxide.

Oxidation reactions and kinetics can be selectively controlled by altering the pH of the wastewater. For example, under alkaline conditions the hypochlorite ion destroys compounds such as glycols, chlorinated alcohols, organic acids, and ketones (Mulligan, 1976), as well as cyanide and organo-metallic pesticides. In using chlorine the potential for creating chloromethanes, chloroamines, or chlorophenols should also be considered.

Hydrogen peroxide oxidizes phenol readily when the reaction is catalyzed by ferrous sulfate; however, it has generally not been economically practical to complete the oxidation to carbon dioxide and water (Strunk, 1979). Hydrogen peroxide can also be used to reduce odor which may be present due to the use of sulfur compounds.

Hydrogen peroxide oxidation removes both cyanide and metals in cyanide-containing waters (U.S. EPA, 1980c). The cyanide is converted to cyanate, and the metals are precipitated as oxides or hydroxides. The metals are then removed from solution by either settling or filtration. This process can reduce total cyanide to less than 0.1 mg/l and metals such as zinc and cadmium to less than 1 mg/l.

Ozone has been shown (Gould, 1976) to completely remove phenol, and provide 70 to 80 percent removal of COD; however, it becomes costly as 100 percent organic removal is approached. Because ozone is unstable and must be generated on-site, safety factors must also be considered when this treatment is selected.

Full-Scale Systems--Tables VI-4 and VI-5 present design and operating data for nine pesticide manufacturers utilizing chemical oxidation. In these systems over 98 percent of cyanide, phenol, and pesticides are removed, while COD and other organics are greatly reduced.

Plant 1 uses batch chemical oxidation treatment of wastewater for five of its pesticide processes. Hydrogen peroxide is used for the reduction of phenolic compounds in the wastewaters from

Pesticides A, C, D, and E. Sodium hypochlorite is used primarily for odor control in the B pesticide process. Although the plant declined to allow EPA contractor sampling to document the effectiveness of these individual pretreatment units, two data points for phenol were observed during screening and verification sampling to be less than 1 mg/l in the combined raw waste load prior to secondary treatment and direct discharge of wastewater at this plant.

Plant 2 adds formaldehyde to cyanide-containing wastewaters to form cyanohydrin, which hydrolyzes to ammonia and glycolic acid, in their F pesticide process discharge. This system is designed to add 1.0 gpm formaldehyde to a 110 gpm waste stream to reduce cyanide from 200 mg/l to less than 1 mg/l after a detention time of four days. Table VI-5 shows that during three days of verification sampling, cyanide was reduced 99.6 percent from 5,503 mg/l to 19.7 mg/l, although these analyses were not conducted per protocol. It should be noted that plant monitoring after chemical oxidation, hydrolysis, steam stripping, and biological oxidation and before direct discharge show cyanide levels reduced to less than 0.0125 mg/l. During verification sampling it was also determined that chemical oxidation removed 99.8 percent of Pesticide F, from 83.2 mg/l to 0.145 mg/l.

Plant 3 has in the past used chlorine chemical oxidation for the purpose of reducing fish toxicity in wastewaters from its G and H pesticide processes. During three days of verification sampling at this treatment unit, only Pesticide H was in production. Table VI-5 shows the results of split samples taken and analyzed by the verification contractor. The principal pollutant removed in the chemical oxidation unit was the Pesticide H, which was reduced by more than 99.9 percent from 398 mg/l to 0.187 mg/l. Plant data have indicated a long-term removal of 83.4 percent Pesticide H.

Significant removal of Pesticides S (63.6 to 99.3 percent), T (99.5 percent), G (90.5 percent), and U (54.4 percent) was observed. When chlorine is added to wastewater containing compounds such as methylene chloride, chemical substitution of hydrogen by halogens may create or increase the concentration of compounds such as chloroform. For example, split verification samples showed chloroform increasing from less than 0.1 mg/l to approximately 1 mg/l. The wastewater from chlorine oxidation at Plant 3 receives subsequent biological treatment before direct discharge.

Plant 4 has recently designed and constructed a hydrogen peroxide oxidation system. Operating data are not yet available. Pretreatment of pesticide and pesticide intermediate wastewater by chemical oxidation was deemed necessary to make this stream suitable for subsequent biological treatment. Treatability studies were conducted which predicted removals of pesticide (48.8 percent), COD (50 percent), and TOC (41 percent), based on addition of 1 percent by volume of hydrogen peroxide after acidification to pH 1 to encourage precipitation. Sodium hypochlorite was found to be an equally effective, and more economical oxidant; however, it was abandoned due to potential formation of chlorinated hydrocarbons. The wastewater from chemical oxidation at Plant 4 receives subsequent biological treatment before direct discharge.

Plant 5 uses hydrogen peroxide to oxidize both phenol and COD in its pesticide wastewaters. As shown in Table VI-5, the phenol is reduced by 99.8 percent from 1,100 mg/l to 2.03 mg/l. This removal was achieved by using a 1:1 ratio of 100 percent hydrogen peroxide to phenol in the plant's aerated lagoon. At the same time, pesticides in the wastewater are reduced to 0.023 mg/l. A 3:1 ratio of 100 percent hydrogen peroxide to phenol has recently been used to improve COD removal. The plant subsequently disposes of wastewater via direct discharge.

Plant 6 operates a chlorine oxidation treatment unit to remove toxic compounds from wastewater generated in the L and M pesticide processes. The wastewater is held approximately one hour at pH 10-12 and temperature of 107°C. Chlorine is added at a rate of 3.25 gallons per 1,000 gallons of wastewater treated. Pesticides are not detected in the effluent discharge from chlorine treatment. The wastewater from chlorine oxidation is subsequently evaporated to achieve no discharge.

Plant 7 uses sodium hypochlorite to remove odor and COD generated by diethylamine from its N pesticide process. Wastewater is held for 0.5 to 8.0 hours at pH 7-12 while 1.5 gallons of sodium hypochlorite bleach (12 to 15 percent available chlorine) is added to each 1,000 gallons. The wastewater from chlorine oxidation is subsequently discharged to a POTW.

Plant 8 is reported to use chemical oxidation for wastewaters from its O, P, and Q pesticide processes. According to the Plant 308 response, no data on this system are currently available. The plant subsequently discharges wastewater to a POTW.

Plant 9 uses chemical oxidation to treat wastewaters from its R pesticide process. Cobaltous chloride is used as a catalyst in the presence of diffused air to oxidize sulfites and other potentially toxic compounds. No analyses of priority pollutants are conducted by the plant. Wastewater from chemical oxidation is disposed of by direct discharge.

Barnes (1978) reports that oxidation by chlorine is a common treatment employed by 90 companies in the electroplating industry for the removal of cyanide. By analyzing data from 58 plants with oxidation treatment, it was concluded that 36 percent achieve total cyanide effluent values less than or equal to 0.04 mg/l and 50 percent achieve total cyanide effluent values less than 0.11 mg/l.

Cyanide may be precipitated and settled out of wastewaters by the addition of zinc sulfate or ferrous sulfate. Data from coil coating plants (EPA 440/1-82/071) using cyanide precipitation show a cyanide mean effluent concentration of 0.07 mg/l.

Treatability Studies--Plant 10 conducted a treatability study on a wastewater containing phosphorous-sulfur compounds, and chlorides. Several chemical oxidants were considered in this study including dichromate, hydrogen peroxide, and permanganate. Treatment with peroxide was the most effective showing COD removals in the 65 to 75 percent range on the raw waste and 45 to 50 percent on the effluent from a nine-stage biological pilot plant.

In the manufacture of cyanuric chloride for triazine pesticides, hydrocyanic acid and cyanic acid may be present. Lowenback (1978) reports that these cyanides may be oxidized to carbon dioxide and nitrogen gas in the presence of excess base and chlorine.

Sweeny (1979) reported complete or nearly complete degradation of selected organic compounds including cyclodienes, atrazine, and DDT type pesticides by methods such as chemical reduction and use of columns (diluted and fluidized beds). The reductive degradation process primarily involved dechlorination, using catalyzed iron as the most effective reducing agent. The use of a column was found to be the most efficient method. Sweeny reported a 99.8 percent p-nitrophenol reduction at a flow rate of 22.8 gpm/sq. ft. in a fluidized bed.

Metals Separation

Metallic ions in soluble form are commonly removed from wastewater by conversion to an insoluble form followed by a separation process. Metallic hydroxides are formed at optimum pH (approximately pH = 9.0 for copper and zinc found in the pesticide industry) through alteration of the ionic equilibrium by an agent such as lime, soda ash, or caustic. Clarification or filtration is normally employed to remove the precipitate from solution. Alternative processes which also remove metals are ion exchange, oxidation or reduction, reverse osmosis, and activated carbon.

Full-Scale Systems--Three priority pollutant metals separation systems are operating in the pesticide industry as shown in Table VI-6. Plant 1 operates a hydrogen sulfide precipitation system in order to remove copper from its A pesticide wastewater. Other separation methods attempted were precipitation of copper using ammonium thiocyanate, and extraction with liquid ionic exchange resins. The operating system consists of an agitated precipitator to which the hydrogen sulfide is added, a soak vessel to which sulfur dioxide is added, a neutralization step using ammonia, followed by gravity separation and centrifuging. Copper is removed from 4,500 to 2.2 mg/l or from 5,350 to 2.8 mg/l.

Plant 2 utilizes sodium sulfide for the precipitation of copper from the B pesticide wastewater. Although removals of copper through precipitation is unknown, verification sampling data by EPA contractors showed copper concentration in all plant process waters to primary secondary treatment to be 23 ug/l.

Plant 3 has installed a chemical precipitation step for the removal of arsenic and zinc from surface water runoff. Ferric sulfate and lime are alternately added, while the wastewater is vacuum filtered and sludge is contract hauled. The entire treatment system consists of dual media filtration, carbon adsorption, ion exchange, chemical precipitation, and vacuum filtration. Verification sampling across the entire system by EPA contractors showed arsenic removal from 6.9 to 0.2 mg/l (97.1 percent) and zinc removal from 0.34 to 0.11 mg/l (67.6 percent).

Barnes (1978) reports that high pH adjustment followed by clarification is a common full-scale treatment employed in the electroplating industry. Data from 25 plants utilizing this treatment show that the average effluent concentrations for copper and zinc are 0.49 mg/l and 0.72 mg/l, respectively.

As reported in the Development Document for the Coil Coating industry, data from 55 full-scale metal separation systems in the metal industry employing pH adjustment and hydroxide precipitation using lime or caustic followed by settling (tank, lagoon, or clarifier) for solids removal show mean effluent concentrations and percent removal for metals as follows:

Metal	No. Data Points	Mean Raw Waste Concentration (mg/l)	Mean Effluent Concentration (mg/l)	Percent Removal
Copper	74	23.2	0.61	97.4
Zinc	69	27.7	0.40	98.6

The Development Document for the Coil Coating Industry also reports long-term data from two plants in the industry using precipitation-settling systems followed by filtration. Both plants neutralize wastewater and precipitate metals with lime. A clarifier is used as settling media. For removal of suspended solids, Plant 4 uses pressure filtration and Plant 5 uses a rapid sand filter. The data from these systems are as follows:

	Plant 4		Plant 5	
Metal	Raw Waste Range (mg/l)	Mean Effluent (mg/l)	Raw Waste Range (mg/l)	Mean Effluent (mg/l)
Zinc	33.2-32.0	0.2	2.35-3.39	0.035
Copper	0.08-0.45	0.0175	0.09-0.27	0.011

These systems confirm that metals can be treated to very low levels by the precipitation process.

Mercury Removal--Only one facility currently uses mercury in the manufacture of metallo-organic pesticides. This plant's data was used as the basis for regulating this pollutant. The plant has classified this data as confidential, however, its mercury effluent data can be summarized as follows;

Long term average - 0.02 mg/l

Monthly variability factor - 1.35

Daily variability factor - 2.34

The plant has reported a removal of 99.99 per cent from the raw waste load.

Treatability Studies--Amron Corporation (1979) reported on a system designed to remove high concentrations of heavy metals in their wastewater. The method is an hydroxide/modified sulfide precipitation system that uses ferrous sulfide an insoluble sulfide salt which has a solubility greater than the heavy metal sulfide to be precipitated. Heavy metal removals reported represent mean values obtained over a 6-month period of operations. Representative percent removals are listed below:

Metal	Influent (mg/l)	Effluent (mg/l)	Removal (Percent)
Phosphorus	247	0.40	99.8
Zinc	27	0.10	99.6+
Iron	85	0.04	99.9
Chromium	2	0.10	95+
Nickel	0.61	0.10	83.6

Lanouette and Paulson (1976) have made a literature review of the various methods employed to treat wastewaters containing heavy metals. Typical estimates of the achievable concentration of heavy metals using precipitation were:

Heavy Metal	Achievable Concentration (mg/l)	Precipitating Agent
Copper	0.5	Caustic, lime
Zinc	0.5	Caustic, lime
Cadmium	0.3	Soda ash
Nickel	0.5	Soda ash
Chromium (total)	0.5	Caustic, lime

Gupta, et al. (1978) reported on a bench test where arsenic was effectively treated from various waters. Experiments were carried out on fresh water, sea water, a 10:1 mixture of fresh water and sea water, and a sodium chloride solution. The best removal rate occurred with arsenic in the +5 oxidation state and a pH of 4 to 7 using columns of activated media. The materials used were activated bauxite, activated alumina, and activated carbon. A summary of the results are listed below:

Percent Arsenic Removal

	Activated Bauxite	Activated Alumina	Activated Carbon
Fresh Water	97-100	99-100	83.5-96.5
Saltwater 1:10	93-97.3	98-99	74.3-95
Sea Water	92.5-97.5	97-99	71.1-92.8
NaCl	87-94	95.8-97	62.6-89.7

Pilot plant tests performed by Muruyama, et al. (1975) evaluated the effect of precipitation with lime or coagulation with iron followed by activated carbon to remove heavy metals from wastewater. Data results are presented in the Activated Carbon Treatability Studies section.

Granular Activated Carbon

Activated carbon adsorption is a physical separation process in which highly porous carbon particles remove a variety of substances from water. Adsorption is affected by many factors including molecular size and weight of the adsorbate, solubility and polarity of the adsorbate and pore structure of the carbon. The characteristics of activated carbon treatment that apply to the pesticide industry may be summarized below:

1. Increasing molecular weight is conducive to better adsorption.
2. The degree of adsorption increases as adsorbate solubility decreases.
3. Aromatic compounds tend to be more readily adsorbed than aliphatics.
4. Adsorption is pH dependent.

Full-Scale Systems--Table VI-7 provides design criteria for 17 plants using activated carbon in the treatment of pesticide wastewaters. Table VI-8 presents operating data on these same systems.

Pesticides, phenols, and nitrosamines are all effectively removed by activated carbon. Volatile organics and oxygen demanding substances can be significantly removed although the degree of removal is plant specific. The majority of these systems use long contact times and high carbon usage rate systems which are applied as a pretreatment for the removal of organics from concentrated waste streams. Three plants operate tertiary carbon systems which use shorter contact times and have lower carbon usage rates.

Plant 1 operates an activated carbon treatment system for wastewaters from nine pesticide processes. Activated carbon is used as pretreatment to remove phenols, Pesticides A, B, and other structurally similar pesticides prior to discharge to a POTW.

Wastewater at Plant 1 first enters a 3,000 gallon surge tank, then is transferred to a 160,000 gallon equalization tank to permit handling a number of separate variable flows on different production schedules from the nine process areas. The equalization tank also permits a constant flow rate for maximizing carbon adsorption efficiency. The adsorbers are sized for 120-gallon per minute flow with normal flow of approximately 50 gallons per minute. The wastewater at pH 1.0 to 1.5 is pumped through two 8,000 gallon Douglas Fir wooden tanks operating in an upflow series mode each containing 18,000 pounds of carbon each. The low pH of the influent stream facilitates adsorption of these phenolic compounds. An empty bed contact time of 320 minutes is provided. The carbon treated effluent is adjusted to pH 5.5 to 9.0 using a lime slurry prior to discharge. Area drainage is treated for phenols as needed by two additional carbon columns of the same size.

As shown in Table VI-8, verification sampling at Plant 1 indicated that total phenol in the effluent from the activated carbon columns averaged less than 0.143 mg/l and 0.329 mg/l from two separate monitoring periods. This represents a 99.8 percent removal of total phenol. Plant operating data over the past two years have shown an effluent phenol level of less than 1.0 mg/l. The columns also remove 99.9 percent of Pesticides A and B.

Plant 1 contracts for off-site thermal reactivation of carbon. Normally, carbon usage is 26 pounds per 1,000 gallons wastewater treated.

Plant 2 uses a two-column series activated carbon treatment system for J and K pesticide wastewater. The downflow carbon system is designed to operate at 30 gallons per minute, 24 hours per day, during a production run. This pesticide production schedule is normally 5 days a week, 24 hours a day. Process wastewater, process area drainage, and spent acid from the manufacturing process are treated in the carbon unit. Each column is charged with 20,000 pounds of carbon. Because both pesticides are batch production units, wastewater and spent acid are fed into holding tanks with several days retention time. The wastewater is treated in the carbon system at a pH range of 0.5 to 4.0 with an empty bed contact time of 588 minutes. Carbon column effluent is combined in a holding tank with other nonpesticide wastewater and pH adjusted prior to direct discharge.

Verification sampling at Plant 2 showed that the concentration of Pesticide K was reduced from a level of 0.465 mg/l to less than 0.001 mg/l constituting a 99.8+ percent removal by the carbon adsorption unit. Previous Pesticide K sampling at this plant during 1977 had shown removal of 99.9 percent to 0.0182 mg/l. Total phenol was reduced to a concentration of less than 0.001 mg/l with a removal of 82.1 percent. The reduction in the concentration of volatile organics was not consistent. The removal of conventional pollutants ranged from 36.2 percent for TSS to 90.7 for TOC.

The carbon usage rate at Plant 2 for this unit is 81.5 pounds per 1,000 gallons. Normal plant procedure requires the carbon bed to be replaced every 30 days. Prior to off-site thermal reactivation carbon is hydraulically pumped from the column into a caustic soda neutralization tank.

Plant 3 operates an activated carbon treatment system for aqueous wastes from the L, M, N, and O pesticide processes. The carbon unit treats 1.2 to 1.4 MGD wastewater and operates 24 hours a day. The system consists of five carbon towers operated in parallel. Normally three towers are in operation. The flow rate into each carbon bed is 3.6 gallons per minute per square foot. The average detention time is 19.1 minutes. Prior to carbon treatment and direct discharge, the wastewater is pH adjusted to 7.0 for maximum carbon adsorption of pesticides and organics present in this stream. Following carbon treatment the wastewater is directly discharged.

The carbon system at Plant 3 removed between 92.3 and 96.9 percent of L, M, and O manufactured pesticides during EPA verification sampling, as shown in Table VI-8. In each case the carbon effluent contained less than 1 mg/l pesticide. Plant 3 reported >85.7 and >91.2 percent removal for Pesticides L and M, respectively, during the period from January 1979 to April 1980. An average carbon effluent concentration of 0.0055 mg/l for Pesticide O was reported for 154 monitoring days.

Halomethanes at Plant 3 were adsorbed with typical removals of 66.3 percent for chloroform and 77.9 percent for carbon tetrachloride. During EPA verification sampling, minimal reductions of low level phenols by carbon treatment were observed. As shown in Table VI-8 there was an increase in BOD across the system. In this case it is likely that organics measured as BOD were desorbed as a result of displacement by more adsorbable influent compounds.

Approximately 20,000 pounds of carbon are exchanged per column every 13 days. The carbon usage rate is calculated as 3.9 pounds per 1,000 gallons of treated wastewater. Plant 3 uses off-site thermal reactivation of carbon.

Plant 4 uses two activated carbon treatment systems for wastewaters from the P and Q pesticide processes. Rain water runoff and spent caustic from air pollution control scrubbers from the P pesticide process passes through activated carbon beds at a rate of 15,000 gallons per day. Effluent from the beds is combined with cooling tower blowdown before treatment in the main biological plant. The carbon system was installed mainly to reduce levels of the pesticide and phenols. Plant data showed that Pesticide P enters the carbon system at a concentration of 9,300 mg/l and is reduced to 1.7 mg/l constituting a 99.9 percent removal. The compound 2,4-dichlorophenol is reduced 99.99 percent from 42,000 to 0.82 mg/l. Other phenols, and volatile organics are also significantly reduced.

The carbon bed dedicated to the Q pesticide process at Plant 4 was installed to treat combined wastewater from the N-isopropyl aniline distillation, the neutralized HCL cleanup effluent, cooling tower blowdown, storm water runoff, and washdown water. Approximately 12,000 gallons per day is treated by this unit prior to combining with other plant effluents in the biological treatment system. The activated carbon bed was designed to remove the pesticide and volatile organics in the wastewater. As shown in Table VI-8, plant data indicated that Pesticide Q was reduced from 15 to 0.01 mg/l. The percent removal is 99.9 percent. Benzene and toluene were reduced by greater than 86.3 percent and 66.7 percent, respectively. Halomethanes and phenols were also reduced by significant levels which ranged from 88.9 to greater than 98.9 percent. The Pesticide Q spent carbon is incinerated without regeneration. No additional information is available for either carbon system.

Plant 5 installed an activated carbon treatment system to treat wastewater from the pesticide process. The major source of wastewater fed to the unit is the aqueous discharge from vacuum filtration of the mother liquor. Approximately 1.30 million gallons per day of wastewater enters the adsorbers at a pH of 6 to 12. The carbon system consists of three 2-stage adsorption trains operated in parallel. The empty bed contact time of each train is 18 to 52 minutes.

System start-up data at Plant 5 showed a pesticide influent concentration of 45.7 mg/l and an estimated effluent concentration of 12.4 mg/l, constituting a 72.9 percent removal. Subsequent analyses during 1978 and 1980 revealed that the carbon system was achieving 96.5 percent pesticide removal with an effluent pesticide concentration of 4.7 mg/l. The carbon usage rate is 20 to 33.5 pounds per 1,000 gallons wastewater treated with a loading of 9 to 15 pounds TOC per 100 pounds carbon. Spent carbon is reactivated on-site by an infrared electric furnace.

Toluene was reported by Plant 5 at 0.1 mg/l, a >98.3 percent removal, following carbon adsorption. The reduction of conventional parameters was inconsistent, with a removal range of zero to 93.7 percent.

Plant 6 operates an activated carbon system as pretreatment for removal of nitrosoamines and Pesticide U from certain process wastes. Amination wastes from the U active-ingredient pesticide process are treated in three carbon columns operating in series. Wastewater enters the system at a pH of 8.5 to 9.5. Between 50,000 to 75,000 gallons per day of wastewater is treated by these adsorbers, and the empty bed contact time is 1,000 minutes. Carbon in the lead column is replaced about once a week, resulting in a carbon usage rate of 136 pounds per 1,000 gallons treated. When produced, V and W pesticide wastewaters are also treated in the same carbon treatment system.

Approximately 0.025 to 0.030 MGD of nitration wastes from the U pesticide intermediate process at Plant 6 are treated by carbon adsorption in three columns operating in series, with a fourth column used for storage. Each column has a bed volume of 2,500 gallons. The pH of the intermediate waste is 1.5. Approximately 571 minutes of contact time is usually required. The arrangement of the columns in the treatment scheme is changed once per day, with the former lead column being placed in storage. Effluent from both series of carbon columns is fed to aerobic biological treatment lagoons, clarified, and passed to tertiary treatment prior to final discharge. Spent carbon is thermally reactivated off-site.

In the amination process carbon system at Plant 6, U pesticide wastes were removed during verification sampling, from 14.6 mg/l to 0.0713 mg/l, or 99.5 percent. Plant data also showed a long-term average removal of from 98.5 to 99.8 percent. The compound N-nitrosodi-n-propylamine was reduced during verification to a level of 0.0041 mg/l, a 99.8 percent removal. Plant data have indicated a long-term removal of from 77.6 to 90.3 percent as shown in Table VI-8. Incidental removal of methylene chloride was also noted. Other parameters not mentioned above did not show a significant decrease in concentration. The nitration carbon system effectively reduced nitrosoamine levels from 82 to greater than 95 percent.

Wastewaters from Plant 7's X and Y batch pesticide processes are treated by an activated carbon system. Pesticide and miscellaneous chemical process wastewater is combined with area drainage and washdown water and sent to carbon treatment. Wastewater first enters an equalization/neutralization pond where the pH is adjusted to between 6 and 8. Neutralized wastewater is pumped to a holding pond and then to the carbon system at the rate of 30,000 gallons per day. The system consists of two carbon columns operating in series. Carbon usage is reported at 20,000 pounds per week (95 pounds per 1,000 gallons treated) at a loading of 0.25 pounds TOC per pound carbon. Based on an approximate bed volume of 5,000 gallons per adsorber, a total system empty bed contact time of 8 hours is realized. Carbon effluent flows to a holding pond and is pumped to a spray aeration pond prior to final discharge.

As shown in Table VI-8, manufactured pesticides at Plant 7 are removed by 99.4 percent and greater. Traditional parameters are reduced by 32.1 to 90.7 percent. Toluene was reduced to a concentration of less than 0.007 mg/l (94.9 percent removal). Other organics were reduced to nondetectable levels. Plant 7 uses off-site, thermal reactivation of spent carbon. As the result of a recent treatability study, Plant 7 plans to construct a biological oxidation system to remove the bulk of the organics from the wastewater. The carbon system would be retained for lower strength wastewaters which have been segregated.

Plant 8 operates two activated carbon columns for process wastewater from the water-based manufacture of Pesticide Z. The columns operate in series, each having a capacity of 20,000 pounds of carbon. At 0.16 MGD, the contact time is approximately 100 minutes. The average usage of carbon is 2.89 pounds per 1,000 gallons treated. Wastewater from the process is first pumped to a holding tank and fed through two multimedia filters to prevent suspended solids from plugging the adsorbers carbon system at a pH of 8 to 12. Effluent from the carbon columns is pH adjusted and clarified before discharge to a municipal treatment facility. The plant uses regenerated carbon supplied by an off-site contractor.

Both verification sampling and plant reports at Plant 8 show a removal of 63.6 to 68 percent for Pesticide Z. This removal is determined by an effluent objective of 10 mg/l for Pesticide Z which has been arbitrarily set by the plant. Greater removal can be achieved, if desired, by more frequent carbon replacement. Total suspended solids were reduced from 77.5 mg/l to 32.3 mg/l, or a 58.3 percent removal.

Plant 9 operates an activated carbon treatment unit for basic (high pH) wastewater from the AA pesticide process. This unit was designed to reduce concentrations of pesticide, monochlorobenzene, and 1,2-dichloroethane which are raw materials used in the reaction process. Wastewater is treated by peroxide oxidation prior to carbon adsorption. Approximately 70,000 gallons per day is passed through this unit before treatment in the central biological treatment system. No data currently exist to document the efficiency of this activated carbon unit since the plant is still in a start-up phase.

Plant 10 uses granular activated carbon as treatment for wastewaters from reactor exterior, and floor washings in the manufacturing area of the BB pesticide process.

Wastewater is stored in 6,000-gallon tanks prior to the two activated carbon columns. Influent wastewater enters at a pH range of 5 to 9. Due to the low volume of wastewater, the flow through the columns is intermittent, operating two to three hours per day. Each column has a capacity of 20,000 pounds of carbon and operates in a downflow mode in series. The approximate detention time is 250 minutes with a carbon usage rate of 69.3 pounds of carbon used per 1,000 gallons wastewater treated. Following carbon treatment, wastewater is held in a storage tank for complete reuse as washwater in order to achieve zero discharge status. Spent carbon is contracted for off-site reactivation.

Both plant and verification monitoring data at Plant 10 show that Pesticide BB can be removed from wastewaters by granular activated carbon at greater than 99 percent removal. In this same treatment system traditional parameters, and halomethanes were also effectively reduced.

Plant 11 operates a granular activated carbon column to treat 0.001 MGD wastewaters from the CC pesticide process and 500 gallons per day of discharge from the DD pesticide process dryer operation. This waste is combined with other process waste, noncontact cooling water and sanitary waste, and passes through an equalization basin, aerobic digestor, and clarifier prior to carbon adsorption. The plant has stated that no operating data are currently available for this treatment system.

Plant 12 uses a tertiary activated carbon unit to treat process waste, once-through cooling water, and surface water runoff from the EE pesticide manufacturing process. Approximately 2,800 gallons per day of wastewater is combined with other nonpesticide waste and passed through primary and secondary treatment as well as a sand filtration system prior to carbon treatment. The carbon system consists of two columns operating in series. Treated effluent is chlorinated before final discharge. Spent carbon is reactivated on-site by a regeneration furnace. Furnace product is combined with fresh carbon makeup, then recycled to the system.

Plant 13 uses tertiary activated carbon columns for wastewater from the FF pesticide process. Wastewater treated by hydrolysis (0.01 MGD) from the FF pesticide process is combined with 0.028 MGD of Pesticide FF intermediate waste and 2.0 MGD of nonpesticide process waste. Preceding carbon treatment, all wastewater passes through equalization, skimming, gravity separation, neutralization, and multimedia filtration. Influent wastewater to the columns has a pH of 6. The three activated carbon columns operate in the upflow mode in parallel. Empty bed contact time is approximately 109 minutes. The amount of carbon in each column is 154,000 pounds. Carbon usage rate is 0.92 pounds of carbon per 1,000 gallons wastewater treated. Plant 13 regenerates spent carbon on-site.

Final plant effluent at Plant 13 contains 4.0 MGD noncontact cooling water; Pesticide FF was recorded at a concentration of 0.00602 mg/l. Pesticide removal through the carbon columns has not been measured. TOC removal averages 29 percent for this high-flow, low carbon usage system.

At Plant 14, Pesticide GG was produced until January 1978. Although the wastewater was discharged to a public treatment system, Pesticide GG was pretreated in an activated carbon system prior to discharge. The raw waste was collected in a 1,000 gallon surge tank, passed through columns (2 feet in diameter by 10 feet high) at a pH of less than 1 with an empty bed contact time of 35 minutes, and stored until analysis had been completed. If the total of all pesticide chemicals was less than 5 mg/l, the wastewater was discharged to the municipal treatment system. If not, it was recycled through the columns again. The carbon was regenerated with isopropanol and the solvent was incinerated. Carbon was replaced approximately twice per year. This system was inefficient because of the small detention time, and the necessity for frequent fresh carbon addition. Low flows allowed frequent recycling. Table VI-8 presents 5-1/2 months of pesticide data by the plant, and 6 days BOD, COD, TOC, TSS, and pesticide chemicals data by the plant, and 17 days of sampling analyzed by the EPA contractor.

Plant 15 installed two activated carbon columns operating in series to treat wastewater from the HH pesticide process. The pH of the wastewater is lowered to approximately pH 2 prior to carbon treatment. The plant reports an empty bed contact time of 7 hours. Approximately 27,700 gallons per day of Pesticide HH wastewater is treated. The carbon usage rate is reported to be 451 pounds per 1,000 gallons treated. Due to the relatively high carbon usage rate, Plant 15 is investigating additional treatment methods. Carbon treatment effluent currently passes through steam stripping for ammonia removal and is combined with other process wastes prior to entering the central biological treatment system for subsequent direct discharge.

Verification sampling at Plant 15 showed that approximately 77 percent of the TOC is removed in the carbon columns. Split sample results reported by the plant indicated an 83.1 percent removal. Analysis of the pesticide parameter by verification sampling resulted in a 99.8 percent removal. However, plant monitoring, and verification split sampling data provided by the plant showed removals of 66.7 and 68.4 percent, respectively. Plant 15 participated in a self-sampling monitoring program which determined a long-term removal efficiency of from 98.6 to 99.9 percent. The influent suspended solids were found in concentrations from 3,000 to 4,094 mg/l. Traditional parameter removals are inconsistent.

Plant 16 uses activated carbon to treat wastewater from the ammonia recovery and neutralization steps of the II pesticide process. Wastewater at pH 11.6 to 12.5 enters two carbon beds operating in a downflow mode in series. The vessel size is 11 feet high by 10 feet in diameter. Approximately 20,000 pounds of carbon is contained in each bed. The empty bed contact time for the system is 91.5 minutes when operated at 120,000 gallons per day flow, and 60.8 minutes when operated at 180,000 gallons per day. Each adsorber is replaced approximately every 2.3 days resulting in a carbon usage rate of 71.6 pounds per 1,000 gallons treated for a flow of 0.120 MGD, and 47.7 pounds per 1,000 gallons at 0.180 MGD. Plant 16 uses off-site reactivation of carbon. Activated carbon effluent flows through an aerated lagoon treatment system prior to discharge to a navigable waterway.

As shown in Table VI-8, Pesticide II was found at a concentration of less than 1,418 mg/l in the carbon influent at Plant 16. Pesticide II was reduced by 77.9 percent to less than 314 mg/l following adsorption. TOC was reduced by 68.4 percent from a concentration of 523 to 165 mg/l.

Plant 17 operates an activated carbon treatment system for stormwater runoff, and washdown water from the JJ and KK pesticide process areas. The small flow of 400 to 500 gallons per day of JJ and KK pesticide wastewater is treated for 30 minutes in each of the two carbon beds. The carbon beds are 8 feet in diameter by 20 feet in height and operate in a downflow mode. The carbon usage rate is 2 pounds per 1,000 gallons treated. An off-site method of spent carbon regeneration is used. Following carbon treatment, wastewater is combined with other process waste, neutralized and clarified prior to entering a series of evaporation ponds, and ultimately is discharged to a navigable waterway.

The pollutants of interest for the KK pesticide process at Plant 17 are chlorobenzene and toluene; however, the plant has stated that no data currently exist to document the carbon system efficiency. However, prior to final discharge both Pesticides JJ and KK were detected at a concentration of 0.002 mg/l. This does indicate that these pesticides are removed by the treatment system to very low levels.

Treatability Studies--A detailed review of activated carbon treatability studies was presented in the Development Document for Effluent Limitation Guidelines for the Pesticide Chemicals Manufacturing U.S. EPA 440/1-78/060e. Additional data received since 1978 are presented below.

Pilot studies were performed at Plant 18 to evaluate biological treatment effluent using a multimedia filter, and four granular activated carbon columns in series. Data showed that granular activated carbon can be applied to reduce total pesticide concentrations in the wastewater from 5.0 mg/l to less than 0.05 mg/l, a removal efficiency of greater than 99 percent.

Plant 19 reported that in-house carbon isotherm studies show essentially complete removal of a pesticide at high carbon dosage levels. The plant currently incinerates its wastewater.

Pilot plant treatability studies were performed by ESE (Beaudet, 1979a) to determine percent removal efficiencies of benzene, toluene, and six selected polynuclear aromatic hydrocarbons (naphthalene, acenaphthylene, fluorene, phenathrene, anthracene, and pyrene). The light hydro-carbon cracking units wastewater normally pretreated by the plant for primary oil separation and solids removal was further pretreated in the pilot plant by granular media filtration, then passed through multiple downflow, granular activated carbon columns. This study showed that benzene and toluene were removed to below detection limits of 10 ug/l from multimedia filtered waste containing 21 to 71 mg/l benzene, and 5 to 13 mg/l toluene. Influent levels as high as 24 mg/l total PNA's (defined as the sum of the individual polynuclear aromatic hydrocarbons monitored) were generally reduced to less than the detection limit of 10 ug/l in 83 percent of the samples analyzed.

Another treatability study by ESE (Beaudet, 1979b) was performed on hydrocarbon process wastewater to determine removal of 1,2-dichloroethane (EDC), and other chlorinated hydrocarbons (1,1,2-trichloroethane, carbon tetrachloride, trichloroethylene, and tetrachloroethylene). Results showed removal of EDC to below detection limits of 10 ug/l from a waste stream containing 14 to 950 mg/l EDC. The other chlorinated hydrocarbons monitored were adsorbed more readily than EDC.

Hydroscience (Toxler, 1980) reviewed the literature to gather performance data on the current use of activated carbon for treating wastewaters from the manufacture of organic chemicals. In general, it was reported that nonpolar, high molecular weight organics with limited solubility generally tend to be more readily adsorbed although there is an upper limit of molecular size above which adsorption is adversely affected. They report that branched-chain compounds are more adsorbable than straight-chain compounds. Aware Engineering (1979) also reported extremely good percent removals of high molecular weight compounds, and erratic removal of several intermediate weight compounds such as naphthalene and dicyclopentadiene.

Hydroscience (Toxler, 1980) reports that the adsorptive capacity of the column could be increased with the increase of the bed depth (contact time). The report shows data illustrating the increase on activated carbon loading of sodium nitrophenol (SNP) with the increase in bed depth. This increase in loading is due to the greater saturation of the upper bed layers as the adsorption zone moves through the column.

Zogorski and Faust (1977) reported on the influence of various operational parameters on the removal of 2,4-dichlorophenol from water via fixed beds of granular activated carbon. One of the parameters studied was the height of the mass transfer zone. This parameter, as it increases, causes greater effluent bed contact time to be required to reduce an organic pollutant to a desired effluent concentration. It was found that the height of the mass transfer zone increased markedly:

1. With an increase in the linear velocity of the fluid,
2. With an increase in the size of the adsorbent, especially for carbon particle sizes greater than 0.65 mm, and
3. When the pH value of the solution exceeds the acidic dissociation constant of the adsorbate.

The effect of pH was also reported by Hydroscience (Toxler, 1980). Dissolved organics generally adsorb more readily at a pH which imparts the least polarity to the molecule. For example, phenol, a weak acid, can be expected to adsorb better at low pH, whereas amines, a weak base, exhibit better adsorption characteristics at higher pH. Influence of substituent groups or adsorbability is also important. For example: (1) The Nitro Group--generally increases adsorbability, and (2) Aromatic ring--greatly increases adsorbability. Huang, et al. (1977) reported that the adsorption rate of phenols decreased in order of phenol, o-aminophenol, pyrocatacol, and resorcinol. For phenols, the adsorption capacity is greatly increased when an amino or hydroxyl group is substituted at the ortho position.

Muruyama, et al. (1975) evaluated the effect of a two-step method that includes precipitation with lime followed by activated carbon to remove heavy metals from water. Pilot plants were dosed with metal concentrations in the influent of 0.5 mg/l for mercury and 5.0 mg/l for all other metals. The representative percent removals obtained are listed below:

Metal	Percent Removal	Metal	Percent Removal
Mn2+	92-98.5	Pb2+	96-99
Ni2+	94-99.5	Cr3+	95-99.5
Zn2+	86-94	Cr6+	94-98
Cu2+	90-96	As3+	80-85
Cd2+	92-99.4	Hg2+	92
Ba2+	85-99		

Tertiary treatment of pesticides was studied (Saleh, 1982) at a 1-MGD pilot plant receiving biologically treated domestic wastewater. Activated carbon treatment was the most effective, with an empty bed contact time of 38 minutes providing nearly complete removal for aldrin, dieldrin, and 2,4-D esters.

Carbon Regeneration

Carbon regeneration is required when the carbon consumption rate for removal of toxic pollutants is very high. For the proposed regulation, the Agency costed on-site carbon regeneration systems for all the pesticides plants that need activated carbon systems, regardless of the flow rates and operating days. This increased the overall carbon treatment cost significantly, particularly for small plants with small waste flow rates and short-operating durations. Since many of the pesticide plants discharge a small quantity of wastewater (less than 0.1 MGD), it is not generally cost-effective for these plants to install on-site carbon regeneration systems.

After a telephone survey of five carbon regeneration firms and vendors of carbon regeneration systems, the Agency found that the average cut-off point for installing on-site systems is approximately 2,000 lbs/day of carbon consumption. Therefore, a combination of 2,000 lbs/day carbon consumption rate and 260 operating days/yr was used to determine the cut-off point. The 2,000 lb/day was based on the following survey of activated carbon suppliers:

Source	Rates Above Which On-Site Regeneration is Used
Calgon, Chicago, IL	1,640 to 2,190 lbs/day
Westvaco, Covington, VA	2,000 lbs/day
Camerou Yakima, VA	2,000 lbs/day
Envirotrol, Sewickley, PA	2,740 lbs/day
Adsorption Systems, Inc., Milburn, NJ	2,739 lbs/day

Resin Adsorption

Adsorption by synthetic polymeric resins is an effective means of removal and recovery for specific chemical compounds from wastewater. Polymeric adsorption has been found to be applicable for all members of the phenol family as well as amines, caprolactam, benzene, chlorobenzenes, and chlorinated pesticides. The adsorption capacity of polymeric resins depends on the type and concentration of specific organics in the wastewater as well as the pH, temperature, viscosity, polarity, surface tension, and background concentrations of other organics and salts. For example, a high salt background will enhance phenol adsorption, while increasing the pH will cause the adsorptive capacity of the resin to change sharply since the phenolic molecule goes from a neutral, poorly disassociated form at low and neutral pH to an anionic charged disassociated form at high pH. As with carbon adsorption, the adsorptive capacity increases as solubility decreases.

The adsorbants used are hard, insoluble beads of porous, cross-linked polymer, and are available in a variety of surface areas and pore-sized distributions. The binding energies of the polymers are normally lower than those of activated carbon for the same organic molecules, thereby allowing solvent and chemical regeneration and recovery to be practiced. Regeneration can be accomplished with caustic, formaldehyde, or in solvents such as methanol, isopropanol, and acetone. Batch distillation of regenerant solutions can be used to separate and return products to the process.

Full-Scale System--Tables VI-9 and VI-10 present design and operating data for the four resin systems in the pesticide industry. Phenol, pesticide, and diene compounds are all being effectively removed by these systems. At least one system realized a significant product recovery via regeneration and distillation.

Plant 1 operates a resin adsorption treatment unit for wastewaters from its A pesticide process. After neutralization and settling in lagoons, the wastewater is filtered through anthracite and sand to remove suspended solids before entering one of two identical vessels filled with amberlite XAD-4 resin. An empty bed contact time of 7.5 minutes is provided at a flow rate of 4 gpm/ft^2. According to plant monitoring, the effluent Pesticide A concentration averages below 0.00123 mg/l, representing a 99.1 percent removal across the resin system. Verification monitoring by EPA contractors confirmed these results by detecting an effluent of 0.00067 mg/l over a 3-day period. During this same sampling period the reduction of volatile priority pollutants such as carbon tetrachloride, chloroform, and chlorobenzene ranged from 28.4 to 59.4 percent, as shown in Table VI-10. The resin effluent is then directly discharged to navigable waters.

The resin system at Plant 1 required regeneration only once in the period of one year. In that instance methanol was used as a regenerant, and then was disposed of as supplemental boiler fuel. Isopropyl alcohol may be used in the future as a regenerant; however, distillation of the solvent, and recovery of pesticide have been ruled out as uneconomical.

Plant 2 designed and installed a resin adsorption system to remove Pesticide B and nitrated phenols from process wastewater. The wastewater is adjusted to pH 4.5 to favor the conversion of sodium nitrophenol (SNP) to para-nitrophenol (PNP), which is much less soluble in water and, therefore, is strongly attracted to the hydrophobic resin. In contrast, SNP is hydrophilic and is not attracted to the resin. The column is chemically regenerated with sodium hydroxide, thereby reconverting PNP back to SNP so that greater than 99 percent can be recovered and reused.

Plant 2 conducted exhaustive studies on the removal of PNP from Pesticide B wastewater by adsorption on XAD-4 resins. They determined that after approximately 100 regeneration cycles the capacity of the resin leveled off at 3.3 lbs PNP/ft^3 of resin. This was conducted at an influent PNP concentration of 1,000 mg/l with approximately 1 mg/l in the resin effluent. The wastewater was to be further treated by activated carbon; however, plant production of Pesticide B was discontinued. Plant 3 constructed a resin adsorption unit in 1976 as part of an EPA demonstration grant for removal of pesticides from wastewaters. The system is preceded by wastewater settling, and pressure filtration; approximately 15 minutes of detention time is provided at a flow rate of 3.5 gpm/ft^2. According to the final report for the demonstration grant (Marks, 1980), it is possible to maintain an average effluent level of 0.005 mg/l for Pesticides C and D with daily values less than 0.01 mg/l. This would represent 95 to 99.5 percent removals. As shown in Table VI-10, between 85.1 and 92.2 percent of the dienes were removed. Volatile toxic organics such as carbon tetrachloride and toluene were removed in the 34.5 to 64.7 percent range. The resin effluent is neutralized and discharged to a POTW.

Although isopropanol was used to regenerate the resin beds at Plant 3 during the EPA demonstration grant, methanol has been found to be equally effective at lower cost. The alcohol can be successfully recovered for use in further regenerations by means of pot distillation, or it can be disposed of as boiler fuel.

Plant 4 operates a resin system for the removal of phenols, Pesticide E, and other structurally similar pesticides. The process wastewater is pretreated by vacuum stripping to prevent toluene from building up in the regenerant. The wastewater is then filtered to remove suspended solids and cooled to prevent crystallization. One part of wastewater is mixed with two parts of recycled resin-treated resin with 15 minutes empty bed contact time. Columns last approximately 13 hours between regenerations. Both the plant and EPA contractors have sampled the resin system. As shown in Table VI-10, Pesticides E, F, and G were removed by 76.5 to 97 percent to levels of approximately 20 mg/l. Phenol and 2,4-dichlorophenol were reduced to levels between 0.5 to 4 mg/l. Toluene was shown to be reduced approximately 60 percent. Additional sampling/analysis of this system is being conducted by EPA Region IV. Resin-treated wastewater is neutralized, and discharged to a POTW.

Plant 4 regenerates the resin with 1-1/2 bed volumes of methanol. The methanol, and desorbed pesticides, and phenols are distilled for product recovery and solvent reuse.

Treatability Studies--Aware (1979) conducted pilot scale studies with adsorbent resins at Plant 3. For a loading rate of 7.5 gpm/ft^2, and an empty bed contact time of 6 minutes, the following average removals were observed:

Parameter	Influent (ug/l)	Effluent (ug/l)	Percent Removal
Pesticide C	123	3.7	96.9
Pesticide D	40	2.1	94.7
Chlordane	283	2.1	99.3
Hexachlorocyclopentadiene	1,129	5.5	99.5
Heptachlor epoxide	11	0.2	98.2
Toluene	2,360	198	91.6
Chloroform	1,430	509	64.4
Carbon tetrachloride	20,950	8,670	58.6
Tetrachloroethylene	34	1.1	96.8
Naphthalene	529	100	81.1

Plant 5 is reported to be conducting bench scale treatability studies using XAD-4 resin for removal of phenols and pesticides in wastewater from their pesticide process.

Hydrolysis

In hydrolysis an hydroxyl or hydrogen ion attaches itself to some part of the pesticide chemical molecule, either displacing part of the group or breaking a bond, thus forming two or more new compounds.

The primary design parameter to be considered in hydrolysis is the half-life of the original molecule, which is the time required to react 50 percent of the original compound. The half-life is generally a function of the type of molecule being hydrolyzed, and the temperature and pH of the reaction. A detailed review of the theory of hydrolysis and laboratory data was presented in the BPT development document for pesticide chemicals. EPA 440/1-781/060e. Additional full-scale and treatability data received since 1978 are presented below.

In assessing the treatability of pesticide compounds, hydrolysis should be considered a logical candidate for the following structural groups: amide type; carbamates; heterocyclic with nitrogen in the ring; phosphates and phosphonates; phosphorothioates and phosphorodithioates; thiocarbamates and triazines EPA 440/1-78/060e. According to this listing, the use of hydrolysis can reasonably be expected to apply to at least one-third of all pesticides manufactured.

Full-Scale Systems--Table VI-11 presents the design data for nine plants employing full-scale hydrolysis treatment systems. Table VI-12 presents operating data for these systems. A detention time up to ten days is used in the industry to reduce pesticide levels by more than 99.8 percent resulting in typical effluents less than 1 mg/l.

Plant 1 hydrolyzes washdown and rainwater runoff from its A pesticide process. Wastewater is adjusted with caustic to raise the pH above 9.0 and detained in one of two identically sized batch hydrolysis basins from 4.5 to 31.0 days. As shown in Table VI-12, Pesticide A concentration is reduced an average of 99.8 percent, from 3,300 mg/l to 5.49 mg/l. The basin effluent is neutralized, and then spray irrigated with zero discharge to navigable waters.

Plant 2 operates a hydrolysis basin for wastewater from its B pesticide process. A pH less than 1 is maintained for 8 to 15 days in order to reduce the Pesticide B concentration by 99.9 percent from 57 mg/l to 0.049 mg/l. The basin effluent is then combined with other plant wastewaters, and sent to a biological treatment plant for subsequent direct discharge.

Plant 3 operates a hydrolysis basin for wastewater from its C pesticide process. The wastewater is detained in one of two identical batch basins for approximately 3 hours at pH 12.7. Steam is added to raise the wastewater temperature to approximately 46°C. As a result, Pesticide C is reduced from 93.7 to 97.9 percent, from approximately 27 mg/l to between 1.7 and 0.56 mg/l. The basin effluent is combined with other plant wastes, and sent to a biological treatment system prior to subsequent direct discharge.

Plant 4 hydrolyzes wastewater from its D and E pesticide processes. The acidic wastewater is hydrolyzed by passing it through a limestone pit, and two parallel holding tanks where the pH is adjusted to between 7 and 10. After 3 to 5 hours detention time in the holding tanks it is further hydrolyzed in four parallel aeration basins for a period of three to five days. Pesticides are reduced by more than 99.9 percent, from 12.2 mg/l to 0.01 mg/l prior to discharge to a POTW.

Plant 5 operates hydrolysis treatment units for 11 of its pesticide processes. A maximum of six vessels are used at any one time, four on a continuous basis, and two on a batch basis. Because the units are relatively small (1,200 to 12,000 gallons), high pH (up to 13+), and high temperature (up to 100° C) is used to hydrolyze pesticides rapidly (within 1 to 4 hours). As shown in Table VI-12, actual plant wastewater sampling demonstrates that all pesticides can be reduced below 1 mg/l (Pesticide K would require an additional 45 minutes detention). After pretreatment by hydrolysis, pesticide wastewater is combined with other plant wastes and sent to biological treatment for subsequent direct discharge.

Plant 6 uses two separate hydrolysis treatment units for wastewaters from its pesticide processes. The Pesticide Q hydrolysis system is a proprietary unit designed to remove more than 95 percent of all pesticide compounds structurally similar to Pesticide Q. Actual verification analyses of this unit were inconsistent with plant and EPA expected results; therefore, a longer term re-sampling study is being planned.

Four other pesticides are hydrolyzed at Plant 6 for 12 hours at 43°C while the pH is maintained between 12 and 14. These pesticides are removed to below their detection limits according to plant monitoring records. After pretreatment by hydrolysis, all pesticide wastewaters are sent to a biological treatment system for subsequent direct discharge.

Plant 7 used both alkaline and acid hydrolysis to remove pesticides from their W and X pesticide wastewaters. A pH of 10 to 12 is maintained for 80 minutes at 104°C in the first hydrolysis unit, while a pH of 4 to 6 is maintained for 50 to 60 minutes at 104°C in the second unit. Pesticide W is reduced from 55 mg/l to nondetectable levels in the system; Pesticide X is reported by the plant to hydrolyze more readily, although no analyses are currently available. After pretreatment by hydrolysis, the wastewater is chemically oxidized and then evaporated with no discharge to navigable waters.

Plant 8 operates a hydrolysis basin for wastewaters from its Y pesticide process. Wastewater is maintained at pH 9.0 for 19 hours at 75°C, during which time the Pesticide Y is reduced from 720 to 90 mg/l. Plant experimental data show that by increasing the temperature to 85°C and increasing the pH to 10.0, the half-life for Pesticide Y would change from 6 to 2 hours. Under such experimental conditions the hydrolysis basin effluent would be approximately 1 mg/l. After pretreatment by hydrolysis, the effluent is combined with other plant wastes and sent to activated carbon treatment for subsequent direct discharge.

Treatability Studies--Plant 9 reports that it is planning to modify its treatment system to use hydrolysis for wastewaters from their pesticide processes. Laboratory data on which these plans are based show percent removal of pesticides to be 97 and 93, respectively, at specific conditions of pH and temperature.

Plant 10 reports that the following pesticides will hydrolyze under alkaline conditions: Z, AA, BB, CC, and DD. Table VI-13 contains hydrolysis data for these compounds.

Plant 11 states that organophosphate pesticides will hydrolyze in warm alkaline water.

Studies on triazine pesticides not reported in the BPT Development Document are presented in Table VI-14. In general, acid hydrolysis provides sufficient degradation to allow feasible fullscale design of systems removing pesticides through 10 half-lives (99.9 percent).

Kinetic studies conducted by Wolfe (1976) indicate second order rate constants for the hydrolysis of atrazine with sulfuric and hydrochloric acid in waters. The reported values at pH 0.5 and $40^{o}C$ plus or minus $0.02^{o}C$ are:

Hydrochloric--(6.9 plus or minus 0.6) x 10-5 kM-1s-1
Sulfuric--(1.9 plus or minus 0.2) x 10-4 kM-1s-1

Half-life for atrazine at the same conditions were calculated as:

Hydrochloric--529 plus or minus 38 minutes
Sulfuric--192 plus or minus 18 minutes

Studies performed by Armstrong, et al. (1967) on atrazine showed that pesticide hydrolysis follows first order kinetics at constant pH, but the rate is also pH dependent. Authors reported hydroxyatrazine as the primary hydrolysis product of atrazine and that it is quite resistant to microbial degradation. However, Kearney, et al. (1969) reported a decrease in phototoxicity proportional to a decrease in the actual concentration of the s-triazine, thereby demonstrating that degradation products do not have herbicidal properties.

Munnecke (1976) reported that seven commonly used organophosphate insecticides were hydrolyzed at rates significantly higher (40 to 1,005 times faster) than chemical hydrolysis through the use of enzymes. Parathion metabolites, such as p-nitrophenol, did not significantly influence enzyme activity. The optimum pH range for enzymatic hydrolysis of the eight organophosphate pesticides range from 8.5 to 9.5 with less than 50 percent activity at pH 7. Munnecke notes that the ability of cell-free enzymes to degradate pesticides has been demonstrated for phenylureas, phenylcarbamates, acylanilides, and phenol herbicides. Through culture enrichment and enzyme production techniques the hydrolysis kinetics on these pesticides may be demonstrated on actual pesticide wastewaters in full scale applications.

In 1978, Munnecke reported that the application of soluble or immobilized enzymes can degrade toxic pesticides to less toxic metabolites. In laboratory studies on parathion hydrolyze activity an immobilized enzyme was stabilized at a half-life of 280 days.

Incineration

Incineration is a controlled process for oxidizing solid, liquid, or gaseous combustible wastes to carbon dioxide, water, and ash. In the pesticide industry, thermal incinerators are employed to destroy wastes containing compounds such as: hydrocarbons (toluene); chlorinated hydrocarbons (carbon tetrachloride, ethylene dichloride, etc.); sulfonated solvents (carbon disulfide); and pesticides. Greater than 99.9 percent pesticide removal, as well as greater than 95 percent BOD, COD, and TOC removal, can be achieved provided that sufficient temperature, time, and turbulene are utilized. It should be noted that sulfur and nitrogen-containing compounds will produce their corresponding oxides and should not be incinerated without considering their effects on air quality. Halogenated hydrocarbons may not only affect the air quality but may corrode the incinerator.

Full-Scale Systems--Table VI-15 provides design data for 14 pesticide manufacturers using incineration for flows ranging up to 39,000 gallons per day.

Plant 1 uses an incinerator to dispose of the centrifugal filtrate and floor washings from the A pesticide process area. Since other nonpesticide organic residues are aslo atomized by the two bricklined incinerators, only 5.7 percent of the wastewater processed is attributed to Pesticide A. The residues sustain combustion in the reactors operationg at 1,400°C. The heat value of waste is estimated at 98,000 BTU per gallon. As shown in Table VI-15, the incinerator capacity is 30 to 35 million BTU per hour for both reactors operationg in parallel using a common scrubber. Steam is continuously fed to the reactors to supply hydrogen to form hydrochloric acid. Because these residues are highly chlorinated, the thermal degradation yields carbon dioxide and hydrochloric acid. The off-gas is water quenched in a carbon block spray tower, tower before venting to atmosphere. The dilute hydrochloric acid from the scrubber system is neutralized and discharged to a municipal treatment system. Prior to incineration, toluene/orthochlorotoluene and Pesticide A raw materials are found at levels of 24 and 8 mg/l, respectively; however, there are no data available for the scrubber discharge waste stream.

Plant 2 uses a Trane thermal incinerator to oxide high strength wastes from six pesticide processes. Sixty percent of incinerator uses been devoted to pesticides; however, on only two occasions for testing purposes has pesticide wastewater been oxidized. In both instances the pesticide wastewaters were mixed with total plant effluents. Therefore, no pesticide data exist for the scrubber discharge.

The incinerator capacity is 36 million BTU per hour and will process an average pesticide wastewater volume of 18,000 gallons per day. The wastewater characteristics for the pesticide portion of the incinerator influent are as follows: 2,700 mg/l phosphorus; 6,200 mg/l sulfur; 60,000 mg/l BOD; 150,000 mg/l COD; and 50,000 mg/l TOC. Plant 3 uses two on-site incinerators to oxidize process off-gases and waste organic liquid streams. One incinerator has a capacity of 8.7 million BTU per hour and is designed to operate in excess of 871°C. This combination liquid-vapor incinerator is entirely devoted to H, I, and J pesticides. The flue gas scrubber effluent is combined with the general aqueous effluent from these pesticides prior to entering the treatment system. At present there are no available data to document removal; however, during the EPA verification visits it was estimated by plant personnel to remove all pesticides.

The second pesticide incinerator at Plant 3 has a capacity of 20 million BTU per hour. This two-stage, John Zink oxidizer is designed to handle effluents with high chemically-bound nitrogen content maintaining acceptably low levels of NOx emissions. This unit is totally dedicated to the K pesticide operation. The design raw waste load data is as follows: TOC 33.0 lbs/1,000 lbs production and TOD 207.8 lbs/1,000 lbs production.

Plant 4 operates two thermal oxidizers used to dispose of wastewater from six pesticide products. One of the oxidizers was built by the John Zink Company, and has rated heat release capacity of 35 million BTU per hour. The second oxidizer has a heat release capacity of 70 million BTU per hour and was built by the Trane Thermal Company.

The thermal oxidizers at Plant 4 were designed to dispose of two different wastes. The first primary feed stream consists of approximately 95 percent organics, and 5 percent water. The second stream consists of approximately 5 percent organics, and 95 percent water. The energy generated in the burning of the primary stream is anticipated to vaporize all water in the secondary stream and to oxidize all of the organics persent. Wastes from the O and P pesticide processes currently use 0.55 and 4.68 percent, respectively, of the incinerator capacity. As shown in Table VI-15, available informtion shows that pesticides incinerated have a combined wastewater volume of 0.0074 MGD.

The incinerator scrubber water at Plant 4 was sampled during the EPA verification program. The scrubber effluent is discharged to the tertiary treatment system t a rate of 0.992 MGD. Cyanide was found at a level of 0.00633 mg/l or 0.0239 pound per day in the incinerator scrubber water. No other conventional or priority pollutants have been measured to determine incinerator efficiency.

Plant 5 operates an incinerator with a capacity of 3,000 BTU per thousand pound feed to dispose of wastes from the manufacture of Pesticides R, S, T, U, and V. Approximately 0.05 MGD of T pesticide wastewater is incinerated. The stream from the extraction phase of Pesticide S production is also incinerated. This stream is 2,000 gallons per day. Waste streams from the reaction processes of Pesticides R and V are also incincerated. Spills, leaks, and scrubber discharge from the U pesticide process are incinerated at a rate of 500 gallons per day.

The incinerator feed at Plant 5 separates into an aqueous and organic phase. The water content of the aqueous phase is approximately 82 percent. At present, 22 percent of the incinerator feed contains pesticide active ingredients. All incinerator feed originates in pesticidde operations. Incineration at Plant 5 effectively reduces levels of the priority pollutants methylene chloride, benzene, and toluene, as well as controlling odor and COD.

Plant 5 incinerator feed data indicate pesticide levels up to 130 pounds per thousand pounds of production. As shown by effluent data from the incinerator's stack gas water scrubbers, pesticide removal is from 50 to 99.9 percent. Traditional parameters average 95.9 percent destruction. Nitrogen destruction average 63.9 percent. A possible explanation for this low destruction is that although initial ammonia may be destroyed, partial destruction of organic nitrogen to ammonia nitrogen results in a significant amount of ammonia in the scrubbing liquid. The effluent from the stack gas water scrubber combines with other plant wastes before biological treatment.

Plant 6 uses an on-site incinerator to treat organic waste from the manufacture of Pesticide W. The organic waste contains all of the reaction byproducts as well as sufficient methanol to keep it fluid. Approximately 5.5 million pounds of incinerator feed was generated in 1977 averaging 10.4 percent Pesticide W, 33 percent methanol, and 56.6 percent byproducts.

The daily flow of Pesticide W organic waste into the incinerator at Plant 6 is 2,000 gallons per day. The incinerator capacity is rated at 10 million BTU per hour and operates between 1,370 and 1,540°C. The dwell time for this unit is 0.4 to 0.6 seconds. There are no scrubber or wastewater discharges from the incinerator. Exhaust gases are vented to the atmosphere. No data currently exist to document the incinerator effficiency.

Plant 7 operates three thermal oxidizers that dispose of organics which have been skimmed off process wastewater from eight pesticide effluents. The incinerators were installed to remove pesticides as well as benzene and toluene before discharge by deep well injection.

As shown in Table VI-15, two of the incinerators at Plant 7 have capacities of 9 million and 12 million BTU per hour, respectively. The pesticide volume oxidized for both incinerators is 276 gallons per day. The average pounds per day incinerated for pesticides and volatiles is shown below:

Organic Liquid Waste	Pounds per Day
Benzene	414
Toluene	322
Pesticide X	23
Other Pesticides (Y-EE)	968
Byproducts	576

Approximately 15 to 20 percent of the units are devoted to the liquid waste.

The third incinerator at Plant 7 mainly oxidizes waste from the X pesticide process. Approximately 60 percent of the unit is devoted to liquid waste. Five hundred and fifty-two gallons per day of pesticide wastewater is incinerated averaging 230 pounds of Pesticide X, 1,705 pounds of toluene, and 2,672 pounds of byproducts. This unit operates at a rate of 20 million BTU per hour.

All incinerators at Plant 7 operate at 815° with an exhaust stack height of 100 feet.

Plant 8 operates a waste gas incinerator which uses FF pesticide waste as supplemental fuel since its heat value is approximately 120,000 BTU per gallon. The source of this waste is still bottoms from the FF pesticide distillation process. The rated capacity of the incinerator is 5 million BTU per hour. Approximately 1,000 gallons per day of FF pesticide waste is fed to the incinerator. There is no air pollution control equipment on the incinerator. The plant has estimated that no FF pesticide residue is in the process wastewater from the plant which is discharged to a navigable waterway.

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All incinerators at Plant 7 operate at 815° with an exhaust stack height of 100 feet.

Plant 8 operates a waste gas incinerator which uses FF pesticide waste as supplemental fuel since its heat value is approximately 120,000 BTU per gallon. The source of this waste is still bottoms from the FF pesticide distillation process. The rated capacity of the incinerator is 5 million BTU per hour. Approximately 1,000 gallons per day of FF pesticide waste is fed to the incinerator. There is no air pollution control equipment on the incinerator. The plant has estimated that no FF pesticide residue is in the process wastewater from the plant which is discharged to a navigable waterway.

Plant 9 operates a J.D. Thorpe incinerator for the destruction of wastes from the manufacture of Pesticides GG and HH. The incinerator treats only pesticide wastes. Organic wastes from the HH pesticide plant, aqueous, and organic solvent wastes from the GG pesticide plant, and some waste from the formulations plant are injected into a firebox, operating at 870 to 3,180°C, with approximately two seconds residence time.

The heat release capacity is 76.7 million BTU per hour. The 39,000 gallons per day of GG pesticide waste which is incinerated by Plant 9 is estimated to be composed of the following:

Compound	mg/l
TOC	35,800
Nitrogen	29,600
Chlorine	39,400
Phosphorus	4,850
Sulfur	33,200

The HH pesticide process at Plant 9 feeds 1,000 gallons per day of waste to the incinerator. The table below gives the characterstics of HH pesticide wastewater:

Compound	mg/l
TOC	4,140,000
Chlorine	301,000
Sulfur	67,900

The source of the high TOC was found to be the HH pesticide solvent bleed stream which is primarily toluene.

The incinerator at Plant 9 was designed to oxidize organic compounds to water and carbon dioxide. Sulfur, chlorine, and phosphorus are converted to sulfur dioxide, hydrochloric acid, and phosphorus pentoxide. The hot exhaust gases are quenched by a recirculating neutral salt water solution, followed by scrubbing a venturi. The venturi operates at pressure drops up to 100 feet of water to remove phosphorus pentoxide. The cooling tower and heat exchanger cool down the exhaust gases from 87.8 to 71.7°C. Over 50 million BTU per hour are recovered from the condensation of water in the stack gases. The recirculating scrubber solution (approximately 0.27 MGD) is neutralized with sodium hydroxide. Solids that remain are sodium sulfite, sodium choride, and sodium phosphate. Sodium sulfite is then oxidized to sodium sulfate in an air oxidizer prior to direct discharge.

The average wastewater characteristics from the incinerated and air oxidized effluent at Plant 9 are shown below:

Compound	mg/l
Pesticide HH	0.0026
Pesticide GG	Not detected
Paraquat*	Not detected
Toxaphene*	Not detected
Captan*	0.0017
Chlordane*	0.00013
Arsenic	2.0
Zinc	3.5
NH3-N	125

* Not manufactured at time of sampling.

Plant 10 operates an on-site Trane thermal oxidizer to dispose of organic and aqueous waste from the manufacture of Pesticide II. Approximately 0.024 MGD of wastewater is oxidized by this unit which is entirely devoted to pesticide wastes. The heat release capacity is 48 million BTU per hour. The incinerator off-gases are passed through an alkaline wet scrubber and into an oxidation tower. The incinerator separator liquid is drained off, mixed with lime, and discharged to a sludge lagoon. The lagoon effluent and oxidation tower condensate (averaging 0.09 MGD) are combined with other plant wastes. The plant has stated that there are no data available for the incineration effluent at Plant 10 which is discharged to a navigable waterway.

Plant 11 incinerates all of the waste produced by the JJ pesticide facility. Both aqueous waste from the aminolysis reaction and nonaqueous still residue from distillation are oxidized. The average aqueous waste flow from the process is approximately 2,900 gallons per day. The incinerator influent contains about 95 to 97 percent water, 1 to 3 percent high molecular weight organics, and 1 to 3 percent inorganic salts. As shown in Table VI-15 the rated capacity of the oil-fired incinerator is 12 million BTU per hour; however, there is no useful heat value from the aqueous waste stream. At present, the incinerator is used only to dispose of process wastewater from Pesticide JJ. Air pollution is controlled by a caustic soda enriched water scrubber. The plant has stated that no data are available for the wet scrubber effluent.

Plant 12 is reported to use an on-site incinerator for aqueous waste from the chlorinator step of the KK pesticide process. No additional details on this system are currently available. Waste from another pesticide product, which cannot be recovered to the process, is used as boiler fuel at Plant 12, thereby allowing no wastewater discharge from this process.

Plant 13 uses two incinerators to dispose of organic waste and vent gases from the LL and MM pesticide processes. In addition, aqueous waste from the toluene purification step of the LL pesticide process is oxidized. Periodically the pressure filtration treatment system contributes organic waste to the incinerator feed. As shown in Table VI-15, one incinerator at Plant 13 degrades 11.1 gallons per day of LL pesticide waste and has a 100-foot exhaust stack. The incinerator capacity is rated at 14 million BTU per hour.

A second incinerator at Plant 13 combines wastes from both the LL and MM pesticide processes. Pesticide MM contributes 105 gallons per day, and Pesticide LL provides 7.6 gallons per day of waste to this 10-million BTU per hour thermal oxidizer. This incinerator has a 100-foot exhaust stack for air pollution control. At present the plant has stated that there are no available data to document the efficiency of these incinerators prior to discharge of process wastewaters by deep well injection.

Plant 14 had installed an incinerator to destroy nonconventional pesticide NN, which is contained in aqueous plant process wastes. Performance testing showed that NN pesticide destruction efficiencies in excess of 99.9 weight percent were achieved at a permitted design feed rate of 6 gpm, oxidizer temperature of 1,800^{O}F, and residence time of 2 seconds. Additional testing showed that 99.9 percent pesticide destruction could also be achieved, if permitted, at feed rates up to 8.4 gpm, oxidizer temperatures as low as 1,427^{O}F, and residence time as low as 1.8 seconds. The 9.5 million BTU per hour incinerator was found to achieve 99.9 percent pesticide destruction under acceptable conditions of combustion efficiency, stack opacity, and sulfur dioxide emissions.

Other Technologies

In addition to the technologies presented above, which are used as the basis for this regulation, there are many other technologies that can be used by pesticide plants on a site specific basis. These are discussed below.

Wet Air Oxidation (WAO)

Wet air oxidation process is a liquid phase oxidation and/or hydrolysis performed at elevated temperature and pressure. The process can be used as a pretreatment step to destroy toxics ahead of conventional biological treatment, or to regenerate powdered activated carbon from a biological treatment system.

Products of oxidation stay in the liquid phase and do not create a secondary air pollution problem. The process can substantially reduce COD of toxic waste streams. When raw waste loads reach a level of 20,000 to 30,000 mg/l COD, the process becomes thermally self-sustaining. Phenols, cyanide, nitrosoamines, dienes, and pesticides have been shown to be effectively removed by WAO.

Treatability Studies--Wilhelmi and Ely (1975) reported that demonstration work on the end of pipe effluent from a pesticide manufacturer, using WAO, reduced the COD/BOD ratio from 3.7:1 to 1.2:1. They also reported that cyanide, in concentrations between 500 and 3,000 mg/l, at an acrylonitrile plant in Japan, has been reduced by over 99.9 percent along with a 95+ percent reduction in COD. In general, they noted that a two-step process of partial oxidation and detoxification by WAO, followed by some type of biological process, can typically result in cod reductions from 55,000 to 300 mg/l.

Wilhelmi and Ely (1976) and Randall and Knopp (1978) reported on the destruction of phenols (more than 99.8 percent) by WAO. It was noted that during the oxidation process higher molecular weight compounds are preferentially oxidized to lower molecular weight intermediate products. High oxidation temperatures, and the use of copper catalysts at lower temperatures, were also proven effective in phenol destruction.

Wilhelmi and Knopp (1978) reported that the WAO system used at the Louisville, Kentucky sewage plant to detoxify spills of hexachlorocyclopentadiene reducing the concentration from 6,000 mg/l to 420 mg/l. WAO tests (Wilhelmi, 1979) showed reductions of nitrosodipropylamine from 170 mg/l to 2 to 3 mg/l and for N-nitrosodimethylamine, reductions from 400 mg/l to 50 ppb.

Zimpro, Inc. (1980) reported on the destruction of pesticide chemicals by WAO. A summary of the pesticides evaluated (identified by structural group) follows:

A. Destroyed at 200°C

* Most of the amide and amide-type pesticides

* Carbamate pesticides

* Urea pesticides, monuron and siduron

* Heterocyclic pesticides with nitrogen in the ring

* The uracil pesticides, bromacil and terbacil

* Phosphorothioate and phosphorodithioate pesticides

- Most of the halogenated aliphatic and aromatic pesticides (except trichlorobenzene, PCNB, dichlorobenzene, ortho, and para)

B. Destroyed at 240°C to 275°C

- All the tested pesticides in the nitro structural group
- The triazines pesticides
- Most of the urea pesticides (except monuron and siduron)

Zimpro, Inc. (1980) also reported that in pilot plant tests, a wastewater composite of about 40 actual pesticides showed a 99+ percent pesticide destruction, and 85 percent COD reduction by WAO.

Solvent Extraction

The use of solvent extraction as a unit process operation is common in the pesticide industry; however, it is not widely practiced for the removal of pollutants from waste effluents. It should be considered as a potential treatment alternative to steam stripping and adsorption systems with product recovery. Solvent extraction is most effectively applied to segregated process streams as a roughing treatment for the removal of priority pollutants such as phenols, cyanide, and volatile aromatics.

Full-Scale Systems--Plant 1 uses solvent extraction for the removal of 2,4-dichlorophenol from pesticide process wastewaters. As a result, Plant 1 has reported that 2,4-dichlorophenol is reduced by 98.9 percent, from 6,710 to 74.3 mg/l.

Treatability Studies--Phenol removal by solvent extraction has been used extensively for the treatment of refinery and coke byproduct waste (Mulligan, 1976). Removals generally range from 90 to 99.9 percent with effluent levels of 1 to 4 mg/l from a feed of 1,500 mg/l when high distribution coefficient solvents were used.

Solvent extraction removals of 97 percent for benzene, ethylbenzene, and TOD have been reported (Earhart, et al., 1977) using isobutylene as the solvent.

Membrane Processes

Reverse osmosis systems place wastewater under pressure in the presence of an osmotic membrane to remove solutes from solution. Molecular size, valency, temperature, pH, suspended solids, and pressure may affect the rejection rate for the membrane. Membrane materials used are cellulose acetate, polymers such as polyamides and polyureas, dynamic membrances using hydrous zirconium oxide and polyacrylic acid, and inorganic membrances. Ultrafilitration systems achieve similar removal of solutes from solution based primarily in molecular size.

Modern ultrafiltration membrances are made from a variety of noncellulosic synthetic polymers such as nylon, vinyl chloride-acrylonirile copolymers, polysulfone, polyvinylidene, etc.

Although no membrane processes are used in the pesticide industry, their application has been demonstrated in the metal industry for recovery of zinc and copper, in the textile industry for recovery of polyvinyl alcohols and mineral oils as well as for removal of dyes, and in the pulp and paper and food industries (Mulligan, 1976).

The Development Document for the Coil Coating Industry (EPA 440/1-82/071) reported the following data from full-scale systems using membrane filtration to remove precipitated metals from wastewater.

	Plant 1			Plant 2		
Metal	In (mg/l)	Out (mg/l)	Percent Removal	In (mg/l)	Out (mg/l)	Percent Removal
Copper	18.0	0.043	99.8	8.0	0.22	97.3
Zinc	2.09	0.046	97.6	5.0	0.051	98.9

CARRE (1977) conducted screening tests on textile wastewater to review the rejection by membrane of various known toxic chemicals and indicators. Eight different types of membranes and 14 parameters (BOD, COD, TOC, dissolved solids, volatile solids, color, phenol,mercury, manganese, iron, nickel, chromium, zinc, copper) were investigated. Rejection data for some specific compounds by Selas Dynamic Zr(IV)-PAA membrane follows:

Parameter	Percent Rejection (mg/l)	Concentration 90-100%	No. of Data
COD	71-99	1600-7100	27 out of 35
BOD	74-99	25-2300	29 out of 38
TOC	82-98	175-2000	26 out of 32
Phenol	86-100	0.66-315	4 out of 7
Zinc	94-99	2.1-18	13 out of 13
Copper	92-99	1.5-5.5	14 out of 14
Nickel	80-98	0.7-3.87	7 out of 10

Rejection data for the cellulose acetate membrane demonstrated good removals at high concentrations over wide fluctuations in pH. These results agreed closely with available literature data. Bench tests, and an extensive literature seach were made by Cabasso, et al. (1975) to determine the applicability of trace organic solutes removal from drinking water by membrane separation. The five membranes evaluated were cellulose acetate, cellulose acetate butyrate, ethyl cellulose, polyamide, and polyurea (NS-1) with the latter two being the most effective. The authors concluded that treatment by reverse osmosis with further treatment by an osmotic concentrator is a reasonable approach, and that high water-solute coupling occurs in transport.

Hyperfiltration treatability studies are currently being conducted on pesticide wastewaters by EPA.

End-of-Pipe Treatment

Biological Treatment

Aerated lagoon, activated sludge, and trickling filter systems are widely used throughout the pesticide industry to remove organic pollutants measured by parameters such as BOD and COD. As shown in Table VI-16, there are: (1) 14 aerated lagoon systems with detention times ranging from approximately 2 days to 95 days, (2) 13 activated sludge systems with detention times from 7.15 to 79 hours, and (3) 4 trickling filter systems.

Conventional and nonconventional pollutant operating data for these systems are presented in Table VI-17. BOD removals ranging from 87.4 to 98.8 percent were achieved at major industry biological systems. COD removals at these same plants ranged from 60.5 to 89.7 percent. Priority pollutant and nonconventional pollutant pesticide (manufactured pesticide) removal in biological systems is described below. The mechanism of pollutant removal may be one or more of the following:

(1) biological degradation of the pollutant, (2) adsorption of the pollutant onto sludge which is separately disposed, or (3) volatilization of the pollutant into the air.

It is well documented that biological systems can be acclimated to wastewaters containing significant concentrations of phenols. For example, Plant 21 operates an aerated lagoon system removing phenol by >93.8 percent from 61.8 to 3.84 mg/l. Plant 16 operates an aerated lagoon with hydrogen peroxide added, which reduces phenol by 99.8 percent from 1,100 mg/l to 2.03 mg/l. Plant 5 reduces 4-nitrophenol by 94.7 percent from 203 mg/l to 10.7 mg/l. Plant 6 reduces 4-nitrophenol by >99.8 percent from 461 mg/l to 1.0 mg/l. Plant 2 reduces 2,4-dinitrophenol by 95 percent from 7.91 mg/l to 0.397 mg/l. In such cases as described above, biological systems achieve priority pollutant phenols removal similar to that of activated carbon, resin adsorption, and chemical oxidation pretreatment systems.

The fate of priority pollutant phenols which reach biological systems, after pretreatment, at approximately 1 mg/l or below is a phenomenon of importance which requires further study. As shown in Table VI-17, the following actual removals have been observed in the pesticide industry:

Priority Pollutant	Percent Removal with Raw Load Below 1 mg/l
Phenol	84.4-96.5
2-Chlorophenol	>83.9
2,4-Dichlorophenol	93.8-97.6
2,4,6-Trichlorophenol	4.5 or less
Pentachlorophenol	39.6-41.0

Data from wood preserving plants in the Timber Industry (ESE, 1978) indicate that pentachlorophenol is removed through biological systems as follows:

Plant	Influent	Effluent	Percent Removal
33	158.0	0.907	99.4
34	1.2	0.032	97.3
35	22.3	0.21	99.1
36	2.7	0.069	97.4

As shown in Table VI-17, approximately 50 percent of the cyanide at a 1 mg/l concentration entering the biological systems at Plants 3 and 13 is removed. Additional data from Plants 3, 7, and 9 indicate that cyanide removals are related to influent concentration, i.e., greater than 50 percent removal is experienced for raw wasteloads greater than 1 mg/l, and less than 50 percent for raw wasteloads less than 1 mg/l.

Air stripping of volatile priority pollutants in biological systems is a phenomenon which has received some study as described in Section VIII (Nonwater Quality Aspects). In general, these pollutants are removed from above about 1 mg/l down to their detection limits of 0.005 to 0.01 mg/l. Actual data from biological systems treating pesticide wastewater are summarized below from Table VI-17:

Pollutant Group	Percent Removal Range	Percent Removal Average
Volatile Aromatics	56.5-99.9	94.6
Halomethanes	22.6-98.5	58.3
Haloethers	90.9	90.9
Chlorinated Ethanes and Ethylenes	9.1-96.3	63.0
Polynuclear Aromatics	>84.8	>84.8

Priority pollutant metals which can be traced to process sources in the pesticide industry are copper and zinc. Table VI-17 shows copper and zinc removals in biological systems to be about 50 percent at influent concentrations of 1 mg/l or less. These metals are adsorbed onto sludge since they are not volatile or biodegradable.

Priority pollutant dienes are not currently biologically treated in the pesticide industry. Due to their relatively low solubility, dienes are not expected to be biodegraded or volatilized (Strier, 1979), but rather like metals will adsorb on sludge.

Pesticides are removed in biological systems to varying degrees, based on the characteristics of the individual compound. Table VI-17 shows that biological systems such as Plants 2, 7, and 13 which are receiving pesticides at approximately 1 mg/l, are achieving removals in excess of 50 percent.

Results from bench scale treatability studies performed by Plant 37 showed that a pesticide in concentrations up to 3,000 mg/l did not inhibit aerobic degradation of sewage at typical aerator food-to-mass ratios.

Plant 5 conducted bench-scale biological studies to determine the removal of COD from pesticide wastewater. An average COD removal of 57 percent was achieved in an aerated lagoon with no equalization and 40 days retention time. A pilot plant with equalization and 20 days retention time achieved an average COD removal of 56 percent. An activated sludge bench unit with 5 days retention (no equalization) achieved an average removal of 44 percent. Plant 5 determined that equalization times of 5 to 10 days should allow the activated sludge system to achieve 57 percent COD removal. After conducting bench-scale and pilot-plant treatability studies, as well as in-plant hydraulic/sampling surveys, Plant 38 has concluded that out of ten alternative schemes including ocean disposal, biological treatment of selected wastes, coupled with evaporation and thermal oxidation of high strength wastes, have been selected.

Plant 39 reported that it will be replacing its activated carbon treatment system with biological oxidation for the treatment of all plant wastes. Startup was planned for after June 1979.

Plant 16 reported phenol degradation with a strain of aspergillus bacteria.

Plant 40 conducted a bench-scale activated sludge study of wastewater from a pesticide process. Over 99 percent destruction of this pesticide was achieved with effluent levels of less than 1.8 ug/l.

Plant 28 has conducted pilot-scale treatability studies on the pesticide consisting of a 20-gallon aerated lagoon with approximately 15 days detention time along with gravity clarification and flocculation. COD removals of 83 percent and BOD removals of 97.5 percent was reported.

Plant 29 reported that spent pesticide fermentation beer, sampled in March 1978, did not inhibit biological activity when added to a bench scale activated sludge unit.

Monnig, et al. (1979) reported results of a bench-scale activated sludge system where carbaryl wastewater was diluted with nine parts of municipal wastewater. Carbaryl, toluene, and COD were all reduced by 90 percent or greater. The influent concentration of the wastewater was: Toluene, 160 mg/l; COD, 4,100 mg/l; Carbaryl, 4.3 mg/l; and NH3-N, 158 mg/l. Carbaryl or alpha-naphthal (which was reported as the hydrolysis product for carbaryl) was not detected above 0.5 ug/l in the test unit effluent. Data indicated that carbaryl is readily degraded in activated sludge systems.

Saldick (1975) reported that cyanuric acid is removed from aqueous chemical plant wastes by treatment of the wastes with active bacteria, under anaerobic conditions, while holding pH between 5.0 and 8.5 at ambient temperature.

Petrasek, et al. (1981) conducted a pilot-plant study to evaluate the behavior, and fate of the volatile organic priority pollutants in a conventional municipal wastewater treatment plant. It was determined that POTW removals of these pollutants were greater than or equal to 95 percent with effluent levels less than 1 ug/l in most cases. Exceptions were 1,1,2-trichloroethane (69 percent) and dibromochloromethane (73 percent). It was also found that volatile organic priority pollutants do not generally partition strongly to the sludge. A direct relationship was observed between a compounds tendency to partition to the sludge and the sludge's octanol/water partition coefficient. Significant quantities of some of the compounds were also found in the off-gases from the aeration basin. Removal by primary clarification and activated sludge treatment for specific compounds to be regulated in the pesticide industry were as follows:

Compound	Percent Removal
Benzene	99
Chlorobenzene	99+
Toluene	95
Carbon tetrachloride	99
Chloroform	97
Methylene chloride	99
Tetrachloroethylene	93

Biological treatment studies were conducted on a bench scale (Kincannon, 1981) in order to observe the removal of specific compounds by biodegradation versus air stripping. The results indicated that overall removal of compounds to be regulated in the pesticide industry ranged between 93 and 99.9 percent. In the case of 1,2-dichloroethane and 1,2-dichloropropane, this removal is accomplished almost entirely by air stripping, rather than by biodegradation as noted and were as follows:

Parameter	Percent Overall Removal	Percent Biodegraded	Percent Air-Stripped
1,2-Dichloropropane	99.4-99.9	0-11.2	88.3-99
Methylene chloride	99.5	94.5	5.0
Benzene	99.9	84.5-85	15.4
1,2-Dichloroethane	98.5	0	97.5-100+
Phenol	99.9+	99.9+	0
Tetrachloroethane	93	0	93
2,4-Dichlorophenol	94	94	0

Preliminary findings of a U.S. EPA program (EPA 440/1-80/301) to study the occurrence and fate of the 129 priority pollutants in 40 POTWs show that, based on the data for the first 20 of the 40 POTWs, 50 percent of secondary treatment plants which utilize the conventional activated sludge process achieve at least 76 percent reduction of total priority pollutant metals, 85 percent reduction of total volatile priority pollutants, and 70 percent reduction of total acid-base-neutral priority pollutants. Median secondary removal rates for specific pollutants to be regulated in the pesticide industry are:

Priority Pollutant	Percent Removal
Zinc	80
Copper	82
Cyanide	54
Toluene	94
Methylene chloride	55
Total phenols	77
BOD	91
COD	83
TSS	92
Tetrachloroethylene	86
Benzene	95
Chloroform	79

Powdered Activated Carbon

Powdered activated carbon (PAC) is used in wastewater facilities to adsorb soluble organic materials, to enhance aerobic biological systems, and to aid in clarification. Powdered carbon can be fed to primary clarifiers, aeration basins, or to separate sludge recirculation clarifiers. The du Pont PACT process, which incorporates PAC addition to the activated sludge system, is the most widely used form of PAC treatment in wastewater. Spent carbon is removed with the sludge and can then be discarded or regenerated in a furnace or wet air oxidation system.

Powdered carbon adsorption has not been widely used on a full-scale basis in the pesticide industry. Plant 1 designed a PACT system but switched to granular-activated carbon because it experienced problems with regeneration by wet-air oxidation.

Plant 2 operates three batch activated carbon units for wastewater from three pesticide processes. Separation wash water from one pesticide is initially treated by extraction, gravity separation, and stripping prior to entering the carbon unit. This unit is designed to remove phenol and pesticide.

Prior to the reaction step in a second pesticide process at Plant 2, wastewater passes through solvent extraction, activated carbon, hydrolysis, and ammonia stripping. One to two percent by weight powdered carbon is mixed with waste from this pesticide in a batch vessel for one hour. The compound 1,2-dichloroethane is felt to be removed by activated carbon; however, no data currently exist from this plant.

Wastewater from the reaction step of a third pesticide at Plant 2 is treated by batch slurry contact activated carbon adsorption. The system is preceded by wastewater extraction, gravity separation, stripping, and chemical oxidation. Carbon treatment was installed to reduce concentrations of pesticide and phenols. Following carbon treatment, wastewater from all three processes is combined with other plant wastes in the general waste treatment plant prior to direct discharge. There is no regeneration of spent carbon.

Advantages of the PACT process system have been reported by DeJohn (1975) and Frohlich (1976). Among possible benefits are:

1. Improved organic pollutant removal (BOD, COD, and TOC).
2. Protection of biological system against upsets by removal of toxic waste components.
3. Greater proportions of nonbiodegradable materials are removed through direct adsorption.
4. Improved operational stability.
5. Nitrification in single-stage aeration systems.
6. Control of foaming.
7. Improved oxygen transfer.

Treatability Studies--DeJohn (1975) reported the performance of four full scale activated sludge systems before and after the addition of powdered carbon:

	Parameter	Before	After
Plant 1	BOD Removal	23%	90 to 95%
Plant 2	Effluent COD	1,800 mg/l	350 mg/l
Plant 2	Effluent TOD	100-1,000 mg/l	less than 20 mg/
Plant 3	TSS & COD	--	40% improvement

Preliminary studies results (Sublette, et al., 1980) showed that PAC effects are not attributable entirely to physical adsorption, but involve biological enhancement. Studies involving the addition of phenol to reactors showed that microcultures are apparently not affected by such toxins when the toxins are adsorbed by the PAC.

Studies to determine the effect of PAC on biogradation of benzene (Allen and Gloyna, 1980) showed that PAC provided a system of benzene uptake by adsorption and release through desorption that essentially controlled and optimized biological oxidation. Cumulative oxygen uptakes as high as 95 percent of the TODC of the final benzene concentrations were observed.

Berndt and Polkowski (1978) reported on powdered activated carbon/wet air oxidation pilot plant studies where removals of pesticides and PCB's were more than 90 percent higher than removals with the existing full scale activated sludge plant. Similarly, the PAC pilot plant effluent residual concentrations of arsenic, phenol, and total cyanides were shown to be about one-half of the values for the activated sludge system. Effluent concentrations of compounds are listed below:

Parameter	Activated Sludge	PAC/WAO Pilot Plant
TOC mg/l	18.2	8.3
COD mg/l	50	16
Chlorinated pesticides ug/l	0.35	0.017
Organo-sulfur pesticides ug/l	15.0	0
Copper mg/l	0.01	0.008
Zinc mg/l	0.08	0.021
NH3-N mg/l	12.4	0.17
PCBs ug/l	0.131	0.008

Flynn, et al. (1979) reported on the operational results of a treatment plant receiving organic chemical manufacturing wastes. The plant, using PACT in conjunction with neutralizers, primary and secondary clarifiers, aerators, and a waste sludge thickener with long sludge age, achieves a dissolved organic carbon (DOC) reduction of approximately 80 percent.

Heath (1980) reports on (two years) operating data for a 40-MGD plant using PACT process to provide combined secondary/tertiary treatment to industrial wastewater. BOD removals of over 96 percent were reported. Other achievements of this system are:

1. The filtration rate of PACT sludge increases with increasing carbon content.

2. There have been no foaming problems in the PACT liquid train, even though the wastewater contains surfactants.

Data showed removal of volatile organics to be generally 90 percent with effluent concentrations around 10 ug/l. The removal of phenol was reported to be between, 94 and an 98 percent and effluent concentration less than 40 ug/l.

Ford and Eckenfelder (1979) report that because many of the organic constituents included in the list of 126 priority pollutants are amenable to carbon adsorption, the attractiveness of the addition of PAC to the activated sludge process for effluent quality control is increasing. Data are presented showing pilot plant performance with PAC addition as follows:

Parameter	Pilot Plant Influent	25 mg/l PAC Addition	50 mg/l PAC Addition
NH3-N (mg/l)	19	0.4	0.1
Phenolics (mg/l)	3.95	0.006	0.002
Soluble COD (mg/l)	294	50	27

Zinc Process for the Removal of Mercury

A process for the removal of mercury from wastewater has been developed and is currently being used by one plant in the metallo-organic pesticide category. Zinc is added to the wastewater and combines with mercury to form an insoluble complex that precipitates out of solution under acid pH conditions. The waste treatment system is a pilot scale operation that operates intermittently. Influent mercury levels of 32000 ppm have been reduced to approximately 20 ppm; a 99.99% removal efficiency. The effluent wastewater is neutralized and contains residual zinc remaining after the reaction with mercury. Zinc effluent concentrations averaged 65 ppm and were as low as 2.5 ppm. A second neutralization step is anticipated to further reduce the zinc levels from the process wastewater, before subsequent discharge.

Equalization

Equalization consists of a wastewater holding vessel or a pond large enough to dampen flow and/or pollutant concentration variation which provides a nearly constant discharge rate and wastewater quality. The holding tank or pond capacity is determined by wastewater volume and composition variability. The equalization basin may be agitated or may utilize a baffle system to prevent short circuiting. Equalization is employed prior to wastewater treatment processes that are sensitive to fluctuations in waste composition or flow.

Equalization basins of 12-hour detention are provided for raw process wastewater as it leaves the plant, and for 24-hour detention before any biological treatment system. Equalization consists of two basins in parallel, each equipped with a floating aerator providing 75 horsepower per million gallons of volume.

Neutralization

Neutralization is practiced in industry to raise or lower the pH of a wastewater stream. Alkaline wastewater may be neutralized with hydrochloric acid, carbon dioxide, sulfur dioxide, and most commonly, sulfuric acid. Acidic wastewaters may be neutralized with limestone or lime slurries, soda ash, caustic soda, or anhydrous ammonia. Often a suitable pH can be achieved through the mixing of acidic and alkaline process wastewaters. Selection of neutralizing agents is based on cost, availability, ease of use, reaction by-products, reaction rates, and quantities of sludge formed.

Neutralization has been provided prior to activated carbon and resin adsorption, pesticide removal, and/or prior to biological treatment.

The neutralization basin is sized on the basis of an average detention time of 6 minutes. Either acid or caustic neutralization may be required. For the purpose of cost estimation, caustic neutralization was assumed since it is the most expensive. The size of the caustic soda handling facilities is determined according to a 100 mg/l feed rate. Caustic soda storage is provided based on 30 days' capacity and is fed by positive displacement metering pumps. Seventy horsepower per million gallons is provided for mixing.

Pump stations are required to bring the process effluents to the treatment plant, and before any carbon adsorption, resin adsorption, or aeration basins; and to recycle backwash water from dual media filters and carbon or resin adsorptin and overflow from sludge thickener, aerobic digestor, and vacuum filters.

Pump stations provide a wet well and three individual pumps which will each handle 50 percent of the daily flow during eight hours of service time. The pumping head is assumed to be 20 feet.

Table VI-1A. Applicability of Treatment Technologies to Various Pollutant Groups

Pollutant Group	Treatment Technology												
	Activated Carbon	Resin Adsorption	Steam Stripping	Hydrolysis	Biological Oxidation	Wet Air Oxidation	Membrane Processes	Metals Separation	Solvent Extraction	Chemical Oxidation	Filtration	Powdered Activated Carbon	Tertiary Carbon
Volatile Aromatics	x	x	1	x	2	x	x	x	x	x	x	x	2
Halomethanes	x	x	1	x	2	x	x	x	x	x	x	x	2
Cyanides	x	x	x	x	2	x	x	x	x	1	x	x	2
Haloethers	x	x	1	x	2	x	x	x	x	x	x	x	2
Phenols	1	1	x	x	2	x	x	x	x	x	x	x	2
Nitro Substituted Aromatics	x	x	1	x	2	x	x	x	x	x	x	x	2
Polynuclear Aromatics	x	x	x	x	2	x	x	x	x	x	x	x	2
Metals	x	x	x	x	2	x	x	1	x	x	2	x	2
Chlorinated ethanes(ylenes)	x	x	1	x	2	x	x	x	x	x	x	x	2
Nitrosamines	1	x	x	x	2	x	x	x	x	x	x	x	2
Phthalates	x	x	x	x	2	x	x	x	x	x	x	x	2
Dichloropropane (ene)	x	x	1	x	2	x	x	x	x	x	x	x	2
Pesticides	1	1	x	1	2	x	x	x	x	1	x	x	2
Dienes	1	1	x	x	2	x	x	x	x	x	x	x	2
TCDD	1	x	x	x	x	x	x	x	x	x	x	x	2
Miscellaneous	—	—	—	—	—	—	—	—	—	—	—	—	—
PCBs	—	—	—	—	—	—	—	—	—	—	—	—	—
Benzidines	—	—	—	—	—	—	—	—	—	—	—	—	—

1 = Primary removal technology.
2 = Secondary removal technology.
— = Pollutant group not likely to be present.
x = Indicates technology was considered but was not a primary or secondary recommendation.

Table VI-IB. Principal Types of Wastewater Treatment/Disposal

Type of Treatment/Dispoal	Number of Plants*
Biological Oxidation	32
Activated Carbon	17
Deep Well Injection	17
Incineration	13
Chemical Oxidation	9
Contract Hauling of All Wastewater	9
Hydrolysis	8
Steam Stripping	8
Multimedia Filtration	7
Evaporation	6
Resin Adsorption	4
Metals Separation	3

* There are a total of 119 plants in industry; however, many have more than one means of treatment/disposal.

Table VI-IC
Pollutants Removed by Selected Technologies

Model Treatment Technology	Priority Pollutants	Non-Conventional Pesticides
(1) Steam Stripping	Carbon Tetrachloride Chloroform Methylene Chloride Methyl Chloride Methyl Bromide 1,3-Dichloropropene Bis(2-Chloroethyl)Ether 1,2,4-Trichlorobenzene 1,2-Dichlorobenzene 1,4-Dichlorobenzene	
(2) Activated Carbon	N-Nitrosodi-N-Propylamine 2,4-Dinitrophenol 2,4-Dichlorophenol Pentachlorophenol	Alachlor Atrazine Bromacil Butachlor Carbendazim Benomyl Complex Carbofuran Dinoseb Diuron Linuron Terbacil Triazine Bentazon Chloropropham Ferbam Mancozeb Niacide PCP Salt Swep ZAC Zineb Silvex Maneb Benfluralin Ethalfluralin Fluometuron 2,4-DB 2,4-D IBE 2,4-D IOE 2,4-DB IBE 2,4-DB IOE 2,4,5-T Trifluralin 2,4-D Simazine Terbuthylazine Terbutryn Isopropalin Neburon Profluralin Prometryn Propazine Propham Propoxur Propachlor
(3) Resin Adsorption	Hexachlorocyclopentadiene BHC-Alpha BHC-Beta BHC-Delta BHC-Gamma Endosulfan-Alpha Endosulfan-Beta Endrin Heptachlor Toxaphene 4-Nitrophenol	
(4) Metals Separation	See Metals	
(5) Chemical Oxidation		Methomyl Oxamyl
(6) Hydrolysis		Azinphos Methyl Demeton Diazinon Disulfoton Fensulfothion Fenthion Metribuzin Parathion Methyl KN Methyl Busan 40 Busan 85 Carbam-S Carbophenthion Chlorpyrifos Chlorpyrifos Methyl Coumaphos DBCP Dioxation KN Methyl Metham Naled Ronnel Stiofos Trichloronate Demeton-O Demeton-S Simetryn Parathion Bolstar Phorate Dichlovos Ethion Malathion Prometon Terbufos

Table VI-2. Plants Using Stripping for Pesticide Wastewaters*

Plant Code	Product/ Process Code	Type Stripper	Flow (MGD)	Stripped Material
1	A	Vacuum	NA	Isobutyl alcohol
	B	Steam	0.0165	Methylene chloride
	C	Steam	NA	Xylene
	D	Steam	NA	Xylene
2	E	Steam	0.01	Chloroform, hexane
	F	Steam	0.05	Chloroform, hexane
	G	Steam	0.06	Chloroform, hexane
3	H	Steam	NA	Ethylene dichloride
	I	Steam	NA	NA
	J	Steam	NA	Methanol
	K	Steam	NA	Toluene
	L	Steam	NA	Toluene
	M	Steam	NA	Methanol
	N	Steam	NA	NA
	O	Steam	NA	NA
	P	Steam	NA	Toluene
	Q	Steam	NA	NA
4	R	Steam	0.072	Ammonia, ethylamine
5	S	Steam	0.09	1,2-dichloroethane
6	T	Steam	0.0326	Ammonia
7	U	Steam	0.048	Methylene chloride
8	V	Steam & Vacuum	0.09	Toluene
	W	Steam & Vacuum	0.06	Toluene
	X	Steam & Vacuum	0.04	Toluene

NA = Not Available
* Proposal Data

Table VI-3. Steam Stripping Operating Data[1]

VOLATILE AROMATICS

Benzene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<0.07	<0.04	42.8
6	<0.050	<0.050	NA
6	ND	ND	NA
8	<0.299°	<0.299°	NA

Toluene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<0.070	<0.041	42.1
6	<0.20	<0.20	NA
6	ND	ND	NA
8	>99.5	29.1	>70.7
8	686	33.8	95.1
8	1,570	86.5	94.5
8	528	24.2	95.4

Chlorobenzene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
6	ND	ND	NA

HALOMETHANES

Methylene chloride

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<159	<0.01°	99.9
6	0.005	0.02	+
6	<0.798	<0.645	19.2

Chloroform

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<0.0623	<0.0010°	98.4
2	70.0*	<5.0*	>92.9
6	<0.30	<0.733	+

Carbon tetrachloride

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<0.0010	<0.0010	NA

Footnotes at end of table.

Table VI-3. Steam Stripping Operating Data (Continued, Page 2 of 2)

CHLORINATED ETHANES AND ETHYLENES

	Trichloroethylene		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<0.070	<0.04	42.9
6	NA	0.01	NA

AMMONIA

	Ammonia		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	>50.0	5.00	>90.0
6	2540	95	96.3
6	7890	98.0	98.8

NA = Not available
ND = Not detected
+ = Concentration increased
° = Analysis not conducted per protocol
* = Data from comingled waste stream
1 = Preproposal Data

Table VI-4. Plants Using Chemical Oxidation for Pesticide Wastewaters*

Plant Code	Pesticide Code	Pesticide Volume Disposed (MGD)	pH	Chemical Oxidant
1	A	NA	NA	Hydrogen peroxide
	B	0.029	NA	Sodium hypochlorite
	C	NA	NA	Hydrogen peroxide
	D	NA	NA	Hydrogen peroxide
	E	NA	NA	Hydrogen peroxide
2	F	0.0634	13-14	Formaldehyde
3	G	0.10	7-11	Chlorine
	H	0.02	7-11	Chlorine
4	I	0.07	1	Hydrogen peroxide
5	J	0.0005	8	Hydrogen peroxide
	K	0.0015	8	Hydrogen peroxide
6	L	0.02	10-12	Chlorine
	M	0.015	10-12	Chlorine
7	N	0.0003	7-12	Sodium hypochlorite
8	O	0.01	NA	NA
	P	0.01	NA	NA
	Q	0.01	NA	NA
9	R	0.0026	NA	Cobaltous chloride

NA = Not Available
* Preproposal Data

Table VI-5. Chemical Oxidation Operating Data[1]

CYANIDE				PHENOLS			
	Cyanide				Phenols		
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
2	5503°	19.7	99.6	5	1100*	2.03*	99.8

MANUFACTURED PESTICIDES

		Pesticides		
Pesticide Code	Plant	Influent mg/l	Effluent mg/l	Percent Removal
F	2	83.2	<0.145	>99.8
S	3	1.33	<0.01	>99.3
S	3	3.46	1.26	63.6
T	3	2.03	<0.01	>99.5
G	3	2.40	0.229	90.5
V	3	2.57	1.19	54.4
H	3	398	0.187	99.9
H	3	19.2	3.19	83.4
U	3	0.013	0.299	+
I	4	NA	NA	98.9†
K	5	NA	0.023*	NA
J	5	NA	0.023*	NA

VOLATILE AROMATICS

	Chlorobenzene				Toluene		
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	ND	ND	NA	3	<0.01	<0.01	NA

Footnotes at the end of table.

Table VI-5. Chemical Oxidation Operating Data (Continued Page 2 of 2)

HALOMETHANES

Carbon tetrachloride				Methylene chloride			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	Trace	0.014°	NA	3	ND	ND	NA

Chloroform

Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	0.0367	1.50	+
3	0.170°	1.90°	+

NA = Not available
ND = Not detected
° = Analysis not conducted per protocol
* = Data from comingled waste stream
† = Pilot plant data
+ = Concentration increased
1 = Preproposal Data

Table VI-6. Plants Using Metals Separation for Pesticide Wastewaters[1]

Plant Code	Pesticide Code	Flow (MGD)	Type of System	Effluent Concentration (mg/l)
1	A	0.06	Hydrogen Sulfide Precipitation	2.2-2.8 (Cu)
2	B	NA	Sodium Sulfide Precipitation	NA
3	C* D*	0.35	Ferric Sulfate, Lime Precipitation	0.2 (As) 0.11 (Zn)

NA = Not Available
* = Previously manufactured metallo-organics.
As = Arsenic
Cu = Copper
Zn = Zinc
1 = Preproposal Data

Table VI-7. Plants Using Granular Activated Carbon for Pesticide Wastewaters[1]

Plant Code	Pesticide Code	Volume Treated (MGD)	pH	Calculated Empty Bed Contract Time	Carbon Usage (lb/1000 gal)	Reactivation Method
1	A	0.0451	1.0-1.5	320 Min.	26.0	Off-site/Thermal
	B	0.0165	1.0-1.5	320 Min.	26.0	Off-site/Thermal
	C	NA	1.0-1.5	320 Min.	26.0	Off-site/Thermal
	D	NA	1.0-1.5	320 Min.	26.0	Off-site/Thermal
	E	NA	1.0-1.5	320 Min.	26.0	Off-site/Thermal
	F	NA	1.0-1.5	320 Min.	26.0	Off-site/Thermal
	G	NA	1.0-1.5	320 Min.	26.0	Off-site/Thermal
	H	NA	1.0-1.5	320 Min.	26.0	Off-site/Thermal
	I	NA	1.0-1.5	320 Min.	26.0	Off-site/Thermal
2	J	0.00453	0.5-4.0	588 Min.	81.5	Off-site/Thermal
	K	0.009	0.5-4.0	588 Min.	81.5	Off-site/Thermal
3*	L	0.40°	7.0	19.1 Min.	3.9	Off-site/Thermal
	M	0.40°	7.0	19.1 Min.	3.9	Off-site/Thermal
	N†	0.40°	7.0	19.1 Min.	3.9	Off-site/Thermal
	O	0.40°	7.0	19.1 Min.	3.9	Off-site/Thermal
4	P	0.015	NA	NA	NA	NA
	Q	0.012	NA	NA	NA	NA
5	R	1.26°	6-12	18-52 Min.	20.0-33.5	On-site/infrared furnace
	S	1.26°	6-12	18-52 Min.	20.0-33.5	On-site/infrared furnace
	T	1.26°	6-12	18-52 Min.	20.0-33.5	On-site/infrared furnace
6	U	0.050-0.075	8.5-9.5 (A)	1000 Min. (A)	136 (A)	Off-site/Thermal
	V	NA	8.5-9.5 (A)	1000 Min. (A)	136 (A)	Off-site/Thermal
	W	NA	8.5-9.5 (A)	1000 Min. (A)	136 (A)	Off-site/Thermal
	Pesticide Intermediate	0.025-0.030	1.5 (N)	571 Min. (N)	NA (N)	Off-site/Thermal

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Fotenotes at end cf Table.

Table VI-7. Plants Using Granular Activated Carbon for Pesticide Wastewaters[1] (Continued, Page 2 of 2)

Plant Code	Pesticide Code	Volume Treated (MGD)	pH	Calculated Empty Bed Contract Time	Carbon Usage (lb/1000 gal)	Reactivation Method
7	X	0.046	6-8	480 Min.	95.0	Off-site/Thermal
	Y	0.047	6-8	480 Min.	95.0	Off-site/Thermal
8	Z	0.16	8-12	100 Min.	2.89	Off-site/Thermal
9	AA	0.07	NA	NA	NA	NA
10	BB	0.02	5-9	250 Min.	69.3	Off-site/Thermal
11	CC	0.001	NA	NA	NA	NA
	DD	0.0005	NA	NA	NA	NA
12	EE	0.0028	NA	NA	NA	On-site/Thermal
13	FF	0.010	6	109 Min.	0.92	On-site/Thermal
14	GG	0.00133	1	35 Min.	NA	On-site/Isopropanol
15	HH	0.0275	2.0	420 Min.	451.0	Off-site/Thermal
	HH	0.0002	2.0	420 Min.	451.0	Off-site/Thermal
16	II	0.12	11.6-12.5	91.5 Min.	71.6	Off-site/Thermal
	II	0.18	11.6-12.5	60.8 Min.	47.7	Off-site/Thermal
17	JJ	0.0005	4.0-10.6	60 Min.	2.0	Off-site/Thermal
	KK	0.0004	4.0-10.6	60 Min.	2.0	Off-site/Thermal

° = Combined pesticide flow.
* = Utilized as tertiary treatment.
† = Production discontinued.
NA = Not Available
(A) = Amination
(N) = Nitration
[1] = Preproposal Data

Table VI-8. Granular Activated Carbon Operating Data[1]

MANUFACTURING PESTICIDES

Pesticides

Pesticide Code	Plant	Influent mg/l	Effluent mg/l	Percent Removal
B	1	7.83	<0.0084	>99.9
B	1	<4.63	<0.0147	99.7
A	1	83.0	0.0428	99.9
A	1	82.5	<0.0359	>99.9
C	1	<0.01	<0.01	NA
K	2	0.465	<0.001	>99.8
K	2	15.5	0.0182	99.9
O	3	NA	0.0055	NA
O	3	0.065†	0.005	92.3
M	3	10.4	<0.92	>91.2
M	3	10.9	<0.342	>96.9
L	3	40.7	<5.84	85.7
L	3	18.1	0.680	96.2
P	4	9300	1.7	99.9
Q	4	15	0.01	99.9
R,S,T	5	133*	4.7*	96.5
R,S,T	5	45.7*	12.4*	72.9
U	6	184	2.82	98.5
U	6	14.6	0.0713	99.5
U	6	3.37	0.004	99.8
Y	7	7.57	>0.01	<99.9
X	7	218	1.26	99.4
Z	8	31.3	<10.0	>68.0
Z	8	41.8	15.2	63.6
BB	10	160.0	<0.025	>99.9
BB	10	477	3.37	99.3
FF	13	NA	0.00602	NA
GG	14	17.2	11.0	36.0
HH	15	7.75	2.45	68.4
HH	15	3460	5.71	99.8
HH	15	320	4.32	98.6
HH	15	1780	1.85	99.9
HH	15	4.2	1.4	66.7
II	16	<1420	<314	77.9

* = Data from comingled waste stream
† = Analysis not conducted per protocol
NA = Not Available
[1] = Preproposal Data

Table VI-8. Granular Activated Carbon Operating Data
(Continued, Page 2 of 6)

PHENOLS

Phenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	44.1	0.197*	99.6
1	<1.82*	<0.081*	95.5
4	0.92	<0.01	<98.9
4	280	0.029	99.9
6	<0.015†	<0.01	33.3
8	ND	ND	NA

2-Chlorophenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<5.09*	<0.0233*	99.5
1	11.2*	<0.010*	>99.9
8	ND	ND	NA
15	0.040	ND	NA

2,4-Dichlorophenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	92.2*	<0.0591*	>99.9
1	NA	0.482°	NA
1	NA	0.498°	NA
1	53.7*	<0.022*	>99.9
4	42,000	0.82	99.9

2,4,6-Trichlorophenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<3.69*	<0.0493*	98.7
1	2.20*	<0.010*	>99.5
4	8700	0.068	99.9
8	ND	ND	NA

Pentachlorophenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
2	<1.0	<0.10†	90.0
6	<0.01	<0.01†	NA

Total phenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<145*	<0.329*	99.8
1	<79.6*	<0.143*	99.8
2	<0.0056	<0.001	82.1
3	0.187	0.118	36.9

NA = Not available
ND = Not detected
† = Analysis not conducted per protocol
° = Reported as total phenol with 2,4-dichlorophenol principal constituent
* = Data from comingled waste stream

Table VI-8. Granular Activated Carbon Operating Data
(Continued, Page 3 of 6)

NITROSAMINES

N-nitrosodi-n-propylamine

Plant	Influent mg/l	Effluent mg/l	Percent Removal
6	0.069	0.0067	90.3
6	0.123	0.0276	77.6
6	1.96	0.0041	99.8
8	ND	ND	NA

VOLATILE AROMATICS

Benzene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<0.01*	<0.01*	NA
4	NA	<0.012	NA
4	0.073	<0.01	>86.3
7	ND*	NA	NA
15	<0.050	<0.050	NA
15	0.02	ND	NA

Toluene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	0.0162*	0.0194*	+
4	NA	<0.006	NA
4	0.03	<0.01	>66.7
5	5.80*	<0.1*	>98.3
5	1.08	NA	NA
5	2.69*	NA	NA
7	0.137*	<0.007*	>94.9
15	ND	ND	NA
15	<0.20°	<0.20	NA

NA = Not available
ND = Not detected
+ = Concentration increased
* = Data from comingled waste stream
° = Analysis not conducted per protocol

Table VI-8. Granular Activated Carbon Operating Data
(Continued, Page 4 of 6)

VOLATILE AROMATICS (continued)

Chlorobenzene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
2	<0.01	<0.01	NA

Hexachlorobenzene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
2	<0.008	<0.001	87.5

Dichlorobenzene†

Plant	Influent mg/l	Effluent mg/l	Percent Removal
2	<0.108	<0.0167	84.5

HALOMETHANES

Methylene chloride

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	3.54*	<3.07*	>13.3
1	1.70*	1.49*	12.5
4	0.88	<0.01	>98.9
4	NA	1.43	NA
6	0.326	<0.010	>96.9
8	ND	ND	NA
10	12.7°	<0.10°	>99.2
15	<0.10	<0.798	+

Chloroform

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<0.0689*	<0.0119*	82.7
1	0.0189	0.0231*	+
3	0.623	0.210	66.3
4	<0.09	<0.01	88.9
4	NA	<0.0233	NA
10	<0.30°	<0.30°	NA

NA = Not available
ND = Not detected
† = Combined dichlorobenzenes: 1,2; 1,3; 1.4.
° = Analysis not conducted per protocol.
* = Data from comingled waste stream
+ = Concentration increased

Table VI-8. Granular Activated Carbon Operating Data
(Continued, Page 5 of 6)

HALOMETHANES (continued)

Carbon tetrachloride

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<0.150*	<0.0261*	82.6
1	<0.0010*	<0.0010*	NA
3	10.5*	2.32*	77.9
4	NA	<0.02	NA
4	<0.91	<0.01	98.9
5	0.39	NA	NA
5	0.168*	NA	NA
5	<0.16*	<0.1*	37.5

CHLORINATED ETHANES AND ETHYLENES

1,2-Dichloroethane

Plant	Influent mg/l	Effluent mg/l	Percent Removal
6	<0.022	<0.012	45.5
4	NA	<0.01	NA

NA = Not Available
ND = Not detected
* = Data fro comingled waste stream

Table VI-8. Granular Activated Carbon Operating Data
(Continued, Page 6 of 6)

TRADITIONAL PARAMETERS

BOD

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	5690*	4136*	27.3
3	137.0*	319.0*	+
5	ND*	<20.0*	+
5	78.8	NA	NA
6	NA	316	NA
7	NA	889*	NA
10	<103	<1.92	98.2
14	45200	37400	17.3
15	3331	2397	28.0

COD

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	8000*	2580*	67.7
2	1500	204	86.4
3	895.0*	819.0*	8.49
5	353*	<285*	>19.3
5	890	NA	NA
5	468*	NA	NA
6	5120	2880	43.7
7	4750*	808*	83.0
10	4880	31.2	99.4
14	148000	109000	26.3
15	28021	5340	80.9
15	75500	60000	20.5

TSS

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	56.6*	185*	+
2	235	150	36.2
3	35.0*	35.0*	0.0
5	411*	25.7*	93.7
5	178	NA	NA
5	253*	NA	NA
6	NA	34.0	NA
7	68.6*	46.6*	32.1
8	77.5	32.3	58.3
10	87.7	<5.00	>94.3
13	<97.0*	<117*	+
14	1460	2600	+
15	4094	204	95.0
15	3000	2000	33.3

TOC

Plant	Influent mg/l	Effluent mg/l	Percent Removal
2	430	40.3	90.6
5	585*	81.0*	86.2
5	178*	NA	NA
7	1650*	153*	90.7
10	2170	15.4	99.3
13	<344*	<245*	28.8
14	79800	66700	16.4
15	28489	6538	77.0
15	19500	3300	83.1
16	523	165	68.4

NA = Not available
+ = Concentration increased
* = Data from comingled waste stream

Table VI-9. Plants Using Resin Adsorption for Pesticide Wastewaters[1]

Plant Code	Pesticide Code	Volume Disposed (MGD)	Flow Rate (GPM/Ft^2)	pH	Empty Bed Contract Time	Regeneration Solvent/Disposal
1	A	0.15	4.0	6-8	7.5 Min.	Methanol/Boiler fuel
2	B*	0.10	1.0	4.5	30 Min.	Sodium hydroxide/Recycle
3	C	0.14	3.5	3-4	15 Min.	Isopropanol/Boiler fuel
	D	0.04	3.5	3-4	15 Min.	Isopropanol/Boiler fuel
4	E	0.09	3.6	1.5	15 Min.	Methanol/Distilled-Reused
	F	0.06	3.6	1.5	15 Min.	Methanol/Distilled-Reused
	G	0.04	3.6	1.5	15 Min.	Methanol/Distilled-Reused

* = Production discontinued
1 = Preproposal Data

Table VI-10. Resin Adsorption Operating Data[1]

MANUFACTURED PESTICIDES

Pesticides

Pesticide Code	Plant	Influent mg/l	Effluent mg/l	Percent Removal
A	1	0.154	0.00067	99.6
A	1	0.142	0.00123	99.1
D	3	0.095	0.038	60.0
D	3	0.320	0.010	96.9
C	3	0.518	0.539	+
C	3	<0.51	<0.015	97.1
E	4	129	24.0	87.5*
E	4	612	18.6	97.0
E	4	<331	<19.5	94.1
E	4	260	61.1	76.5
E	4	248	26.7	89.2
F	4	<152	<18.3	88.0
G	4	71.1	<9.24	>87.0

PHENOLS

2-Chlorophenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	<0.152	<0.01	93.4
4	0.162	<0.0314	>80.6
4	<0.718	<0.069	90.4

2,4-Dichlorophenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	5.76	0.523	93.9*
4	<10.5	<4.32	58.9
4	3.15	<0.462	>85.3
4	5.46	<1.53	>72.0

2,4,6-Trichlorophenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	<0.348	<0.163	68.8*
4	0.378	<0.0892	>76.4
4	<0.544	<0.219	59.7

4-Nitrophenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
2	1000†	1.00†	99.9

NA = Not available
ND = Not detected
* = Removal based on pollutant mass balance, not concentration
† = Pilot scale data
†† = Reported at total phenol with 2,4-dichlorophenol as principal constituent
+ = Concentration increased
1 = Preproposal data

Table VI-10. Resin Adsorption Operating Data (Continued, Page 2 of 4)

PHENOLS (Continued)

Phenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	3.82	1.15	69.8*
4	0.955	0.518	45.8

DIENES

Hexachlorocyclopentadiene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	0.827*	0.123*	85.1
3	0.435*	0.034*	92.2

Hexachlorobutadiene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	0.210*	0.01*	91.1*

VOLATILE AROMATICS

Benzene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<0.053	<0.032	34.5**
4	<0.298	NA	NA

Toluene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	2.10*	0.742*	64.7
4	16.8	8.76	65.2**
4	<171	<79.6	53.5
4	20.8	19.8	63.1
4	25.2	<16.4	>34.9
4	82.9	NA	NA

NA = Not available
* = Data from comingled waste stream
** = Removal based on pollutant mass balance, not concentration

Table VI-10. Resin Adsorption Operating Data (Continued, Page 3 of 4)

VOLATILE AROMATICS (Continued)

Chlorobenzene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	0.577	0.151	39.2**

HALOMETHANES

Chloroform

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	6.19	2.51	59.4
3	0.382*	0.339*	11.2

Chlorodibromomethane

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<0.0063	0.005	<13.8**

Carbon tetrachloride

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	8.07	5.49	28.4**
3	67.9*	44.5*	34.5

POLYNUCLEAR AROMATIC HYDROCARBONS

Naphthalene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	1.06*	0.297*	72.0

* = Data from comingled waste stream
** = Removal based on pollutant mass balance, not concentration

Table VI-10. Resin Adsorption Operating Data (Continued, Page 4 of 4)

CHORINATED ETHANES AND ETHYLENES

Tetrachloroethylene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	0.054	0.018	55.3**
3	0.467*	0.199*	57.4

TRADITIONAL PARAMETERS

BOD

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	55.0	55.0	0.0
3	331*	278*	16.0
4	1906	2104	+

COD

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	674	576	17.9**
3	675*	545*	19.3

TSS

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	23.0	19.0	25.0**
3	208*	81.3*	60.9

TOC

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	62.0	59.0	3.85**
3	342*	301*	12.0
4	2670*	2590	3.0

* = Data from comingled waste stream
** = Removal based on pollutant mass balance, not concentration
+ = Concentration increased

Table VI-11. Plants Using Hydrolysis for Petsicide Wastewaters*

Plant Code	Pesticide Code	Pesticide Volume Disposed (MGD)	pH	Detention Time	Temperature	Type System
1	A	0.00451	>9.0	>108 Hrs.	Ambient	Batch
2	B	0.056	<1.0	264 Hrs.	Ambient	Continuous
3	C	0.025	12.7	3 Hrs.	46.1°C	Batch
4	D	NA	<10	120 Hrs.	NA	Continuous
	E	NA	<10	120 Hrs.	NA	Continuous
5	F	NA	11-12	Variable	30°-40°C	Continuous
	G	NA	8-12	Variable	65°-100°C	Batch
	H	NA	8-12	Variable	65°-100°C	Batch
	I	NA	12+	Variable	100°C	Continuous
	J	NA	8-12	Variable	65°-100°C	Batch
	K	NA	12+	Variable	100°C	Continuous
	L	NA	12+	Variable	100°C	Continuous
	M	NA	13+	Variable	30°-35°C	Continuous
	N	NA	8-12	Variable	65°-100°C	Batch
	O	NA	12+	Variable	100°C	Continuous
	P	NA	12+	Variable	100°C	Continuous
6	Q	0.0634	NA	NA	NA	Continuous
	R	0.006	12-14	12 Hrs.	43.3°C	Continuous
	S	0.015	12-14	12 Hrs.	43.3°C	Continuous
	T	0.025	12-14	12 Hrs.	43.3°C	Continuous
	U	0.007	12-14	12 Hrs.	43.3°C	Continuous
	V	0.013	12-14	12 Hrs.	43.3°C	Continuous
7	W,X	0.02-0.015	10-12	80 Min.	104°C	Continuous
	W,X	0.02-0.015	4-6	50-60 Min.	104°C	Continuous
8	Y	0.010	9	19 Hrs.	75°C	Continuous

NA = Not avialable
* = Preproposal data

Table VI-12. Hydrolysis Operating Data[1]

Pesticides				
Pesticide Code	Plant	Influent mg/l	Effluent mg/l	Percent Removal
A	1	3300	5.49	99.8
B	2	57	0.049	99.9
C	3	27.0	0.56	97.9
C	3	26.8	1.7	93.7
E	4	12.2**	<0.01**	>99.9
D	4	12.2**	<0.01**	>99.9
G	5	20	<1.0*	>95.0
F	5	50	<1.0*	>98.0
J	5	50	<1.0*	>98.0
N	5	60	<1.0*	>98.3
L	5	60	<1.0*	>98.3
H	5	60	<1.0*	>98.3
K	5	104	4.0	96.1
P	5	150	<2.0*	>98.7
O	5	200	1.0*	99.5
I	5	300	<1.0*	>99.7
M	5	1000	<2.0*	>99.8
Q	6	NA	NA	>95.0†
V	6	NA	<0.01	NA
U	6	NA	<0.1	NA
T	6	NA	<0.1	NA
S	6	NA	<0.01	NA
R	6	NA	<0.5	NA
X	7	NA	ND†	NA
W	7	55	<0.001	>99.9
Y	8	720	90.8	87.4

NA = Not analyzed
ND = Not detected
* = Sampling has demonstrated that cited effluent removal is achievable; average varies based on pH, temperature, and detention time.
† = Design basis
** = Hydrolysis and biological oxidation treatment combined
1 = Preproposal Data

Table VI-13. Plant 10 Hydrolysis Data for Thiocarbamate Pesticides*

Pesticide Code	pH	Temp (°C)	Half-Life (Hours)
Z	10	20	Less than one hour
AA and BB	3	20	1.0
		35	0.45
		50	0.27
	6	20	2.7
		35	2.7
		50	5.0
	9	20	12.9
		35	8.0
		50	6.0
CC	3	20	Greater than 40 days
	6	20	Greater than 40 days
	9	20	72
DD	4	30	120
	4	60	50
	8	30	Less than 24 hours
	8	60	Less than 24 hours

* = Preproposal Data

Table VI-14. Hydrolysis Data--Triazine Pesticides*

Pesticide	pH	Temp (°C)	Half-Life (Hours)	Reference
Atrazine	13	25	48	Armstrong, et al., 1967
	0.5	40	3.3	Lowenbach, 1977
	1	25	80	Little, et al., 1980
	1	80	4.7	Little, et al., 1980
	3	25	331	Little, et al., 1980
	12	25	295	Little, et al., 1980
	14	25	4.5	Little, et al., 1980
	16	80	0.27	Little, et al., 1980
Cyanazine	1.55	25	30	Brown, et al., 1972
Prometryn	1.0	25	22	Kearney, et al., 1969
Ametryne	11	41	133	LAI, 1977
	1	41	22	LAI, 1977
	0.5	41	10	LAI, 1977
Metribuzin	11	23	270	LAI, 1977
	11	41	236	LAI, 1977
	1	23	19	LAI, 1977
	1	41	9	LAI, 1977
Cyprazine	1	23	43	LAI, 1977
	1	41	8	LAI, 1977
Simazine	1	23	33	LAI, 1977
	1	41	8	LAI, 1977
Atratone	11	23	420	LAI, 1977
	11	41	290	LAI, 1977
	1	23	176	LAI, 1977
	1	41	48	LAI, 1977

* = Preproposal Data

Table VI-15. Plants Using Incinceration* for Pesticide Wastewaters[1]

Plant Code	Pesticide Code	Pesticide Volume Incinerated (MGD)	Incinerator Capacity (BTU/HR)	Percent Devoted to Pesticide
1	A	0.000234	30-35 x 10^6	5.7
2	B	NA	36.0 x 10^6	60
	C	NA	36.0 x 10^6	60
	D	NA	36.0 x 10^6	60
	E	NA	36.0 x 10^6	60
	F	NA	36.0 x 10^6	60
	G	NA	36.0 x 10^6	60
3	H	NA	8.7 x 10^6	100
	I	NA	8.7 x 10^6	100
	J	NA	8.7 x 10^6	100
	K	NA	20.0 x 10^6	100
4	L	NA	35.0 x 10^6 and 70.0 x 10^6	NA
	M	NA	35.0 x 10^6 and 70.0 x 10^6	NA
	N	0.0028	35.0 x 10^6 and 70.0 x 10^6	NA
	O	0.0013	35.0 x 10^6 and 70.0 x 10^6	0.55
	P	0.0033	35.0 x 10^6 and 70.0 x 10^6	4.68
	Q	NA	35.0 x 10^6 and 70.0 x 10^6	NA
5	R	NA	3000 BTU/lb feed	100
	S	0.002	3000 BTU/lb feed	100
	T	0.05	3000 BTU/lb feed	100
	U	0.0005	3000 BTU/lb feed	100
	V	NA	3000 BTU/lb feed	100
6	W	0.002	10 x 10^6	NA

Footnotes at end of table.

Table VI-15. Plants Using Incinceration* for Pesticide Wastewaters (Continued, Page 2 of 2)

Plant Code	Pesticide Code	Pesticide Volume Incinerated (MGD)	Incinerator Capacity (BTU/HR)	Percent Devoted to Pesticide
7	X	NA	20.0×10^6	NA
	Y	NA	9.0×10^6 and 12.0×10^6	NA
	Z	NA	9.0×10^6 and 12.0×10^6	NA
	AA	NA	9.0×10^6 and 12.0×10^6	NA
	BB	NA	9.0×10^6 and 12.0×10^6	NA
	X	NA	9.0×10^6 and 12.0×10^6	NA
	CC	NA	9.0×10^6 and 12.0×10^6	NA
	DD	NA	9.0×10^6 and 12.0×10^6	NA
	EE	NA	9.0×10^6 and 12.0×10^6	NA
8	FF	0.0010	5.0×10^6	NA
9	GG	0.039	76.7×10^6	100
	HH	0.001	76.7×10^6	100
10	II	0.024	48.0×10^6	100
11	JJ	0.0029	12.0×10^6	100
12	KK	NA	NA	NA
13	LL	0.0000111	14.0×10^6	NA
	MM	0.000105	10.0×10^6	NA
	LL	0.0000076	10.0×10^6	NA
14	NN	0.115	9.5×10^6	100

* = Refers to the disposal of gaseous and organic liquid streams by specific incinceration facilities, not as a supplemental fuel in boilers.

1 = Preproposal Data

NA = Not available

Table VI-16. Plants Using Biological Treatment for Pesticide Wastewaters*

Plant Code	Products Manufactured	Type of System	Detention Time (Hours)	Activated Sludge MLSS (mg/l)
1	Pest, Inter, Form, Other	AL	96	--
2	Pest, Inter Other	TF	NA	--
3	Pest, Inter, Form, Other	AL;AL	240;120	--
4	Pest, Inter, Form, Other	AS;TF	5	2,000
5	Pest, Inter	AL	2,280	--
6	Pest	AS	139	35,000
7	Pest, Inter, Form, Other	AS	7.15	6,000
8	Pest, Inter, Form, Other	AS;AL	79	>3,000
		AL	367	--
9	Pest, Inter, Form, Other	AL	2,160	--
		AS	55	2,000
10	Pest, Inter, Other	AL	NA	--
11	Pest, Form	AS	79	8,720
12	Pest, Other	AS	NA	NA
13	Pest, Inter, Form, Other	AL;AS	51.1	NA
14	Pest, Inter, Other	AS	60	NA
15	Pest, Inter, Form, Other	AL	288	--
16	Pest, Inter, Form	AL;TF	192	--
17	Pest, Inter, Form, Other	AS	NA	NA

Footnotes at end of table.

Table VI-16. Plants Using Biological Treatment for Pesticide Wastewaters*
(Continued, page 2 of 2)

Plant Code	Products Manufactured	Type of System	Detention Time (Hours)	Activated Sludge MLSS (mg/l)
18	Pest, Inter, Form, Other	AS	NA	NA
19	Pest, Other	AL	NA	--
20	Pest, Inter, Form	AL	NA	--
21	Pest, Other	AL	206	--
22	Pest, Other	AL	NA	--
23	Pest, Inter, Other	AS	NA	NA
24	Pest, Other	AS	NA	NA
25	Pest, Inter, Form, Other	AL	NA	--
26	Pest, Inter, Form, Other	AS	24	NA
27	Pest, Inter, Other	AL;AS	NA	NA
28	Pest, Other	AL	420	--
29	Pest, Inter, Other	AS	NA	NA
30	Pest, Inter, Form, Other	AL	NA	--
31	Pest, Inter, Other	AS	NA	NA
32	Pest	AS;TF	3.2	NA

Pest = Pesticides
Inter = Pesticide Intermediate
Form = Pesticide Formulations
NA = Not Available
AS = Activated Sludge
AL = Aerated Lagoon
TF = Trickling Filter
MLSS = Mixed-Liquor Suspended Solids
Other = Manufacture of other chemical products
* = Preproposal Data

Table VI-17. Biological Treatment Operating Preproposal Data

CONVENTIONAL POLLUTANTS

BOD				TSS			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	92.0*	39.0*	57.6	1	NA	18.0*	NA
1	179*	15.3*	91.4	1	NA	22.8*	NA
3	1940*	96.5*	95.0	3	269*	50.1*	81.4
3	2082*	122*	94.1	3	375*	66.8*	82.2
4	120*	8.0*	93.3	4	59.0*	39.0*	33.9
5	4320	1820	57.9	5	NA	501	NA
6	NA	12.7*	NA	5	360	NA	NA
7	928*	73.6*	92.1	6	NA	20.8*	NA
9	19.0*	<1.0*	>94.7	7	595	62.5	89.5
9	675	29.6	95.6	8	5320*	NA	NA
11	694*	12.2*	98.3	9	38.7	101	+
13	610*	7.0*	98.8	9	47.6*	35.0*	26.5
15	1131*	NA	NA	11	39.2*	28.4*	27.5
16	NA	253	NA	13	3.0*	1.8*	40.0
18	572*	NA	NA	15	1394*	NA	NA
20	NA	74.3	NA	18	350*	NA	NA
20	1000	NA	NA	20	NA	81.2	NA
20	2000	NA	NA	20	100	NA	NA
26	905*	114*	87.4	20	300	NA	NA
28	2000*	50.0*	97.5	26	140*	27.3*	80.5
29	7200*	NA	NA	26	340*	64.0*	81.2
				28	<100*	92.0*	<8.00

NA = Not available
* = Data from comingled waste stream
+ = Concentration increased

Table VI-17. Biological Treatment Operating Preproposal Data (Continued, Page 2 of 13)

NONCONVENTIONAL POLLUTANTS

COD

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	429	299	30.3
3	5870*	2320*	60.5
5	9740	3390	65.2
6	436*	127*	70.9
7	4290*	1280*	70.2
8	5250*	NA	NA
9	137*	60.3*	56.0
9	1480	537	63.7
11	1550*	160*	89.7
13	1600*	290*	81.9
15	2382*	NA	NA
18	5800*	NA	NA
20	NA	515	NA
20	2450	NA	NA
20	4900	NA	NA
21	2191*	394*	82.0
22	5250	NA	NA
26	2630*	519*	80.3
26	2830*	336*	88.1
28	4500*	770*	82.9
29	14000*	NA	NA

TOC

Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	110*	104*	5.45
1	122*	NA	NA
3	1810*	621*	65.7
8	3230*	NA	NA
26	900*	100*	88.9
26	3680*	136*	96.3

TOD

Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	7430	3094*	58.4
13	NA	408*	NA

NA = Not available

* = Data for comingled waste stream

Table VI-17. Biological Treatment Operating Preproposal Data (Continued, Page 3 of 13)

MANUFACTURED PESTICIDES

	Pesticides				Pesticides (Continued)		
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	NA	0.0452	NA	7	<0.0336	<0.0394	+
1	NA	0.0452	NA	7	0.0817	0.067	18.0
2	1.56	0.101	93.5	7	0.0918	0.0197	78.5
2	12.2	<0.00183	>99.9	7	0.189	0.148	21.7
3	0.00213	0.00175	17.8	7	0.439	0.0836	81.0
3	0.00846	0.00149	82.4	7	0.753	0.0946	87.4
3	0.615	0.0554	91.0	7	<0.820	<0.254	69.0
3	<0.684	0.533	22.1	7	<0.850	<0.105	87.6
3	<3.67	<1.62	55.9	7	1.03	<0.129	87.5
3	<4.93	<4.17	15.4	7	3.02	0.0685	97.7
3	<6.32	<4.19	33.7	7	3.58	0.49	86.3
3	<6.64	<4.31	35.1	8	1100	114	89.6
3	<7.67	<4.67	39.1	9	NA	<0.012	NA
3	<8.51	<5.37	36.9	9	NA	<0.011	NA
3	<15.8	<14.5	8.23	9	NA	<0.5	NA
3	<17.7	<18.4	+	9	NA	<0.01	NA
3	<23.5	<27.0	+	9	<0.10	<0.10	NA
3	45.9	0.184	99.6	11	3.56	2.08	41.6
4	0.023	<0.01	>56.5	11	13.8	10.3	25.3
4	0.120	0.05	58.3	11	18.0	0.012	99.9
4	0.20	<0.0001	>99.9	11	30.3	NA	NA
4	0.470	<0.010	>97.9	11	104	NA	NA
4	0.240	<0.0001	>99.9	11	136	NA	NA
4	1.11	0.011	99.0	13	0.207	0.164	20.8
4	3.00	<0.010	>99.7	13	1.48*	0.783*	47.1
5	0.084	0.0093	88.9	13	1.48*	0.783*	47.1
5	0.0507	0.0169	66.7	13	19.9	3.20	83.9
6	12.2†	<0.01†	>99.9	13	29.0	<1.0	>96.5
6	12.2†	<0.01†	>99.9	13	180	1.67	99.1
7	<0.010	<0.010	NA	13	6.84	<0.279	>95.9
7	0.019	0.027	+	13	2.80	0.255	90.9
				13	26.2	15.3	41.6

NA = Not avialable
ND = Not detected
+ = Concentration increased
* = Data from comingled waste stream
† = Hydrolysis and biological oxidation treatment combined

Table VI-17. Biological Treatment Operating Preproposal Data (Continued, Page 4 of 13)

MANUFACTURED PESTICIDES (Continued)

Plant	Pesticides (Continued) Influent mg/l	Effluent mg/l	Percent Removal
13	292	1.40	99.5
13	326	<2.0	>99.4
16	NA	0.023	NA
16	NA	0.023	NA
20	NA	<0.05	NA
20	NA	<0.05	NA
20	NA	<0.2	NA
21	0.58*	0.35*	39.6
22	NA	<1.0	NA
26	3.63	0.88	75.7
26	3.05*	0.378*	87.6
26	3.05*	0.378*	87.6
26	0.979*	0.362*	63.0
26	0.979*	0.362*	63.0
26	9.40*	0.170*	98.0
26	5.90*	0.080*	98.6
28	16.0	10.0	37.5

NA = Not available
ND = Not detected
* = Data from comingled waste stream

Table VI-17. Biological Treatment Operating Preproposal Data (Continued, Page 5 of 13)

VOLATILE AROMATICS

Benzene				Toluene			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	2.68*	<0.01*	>99.6	3	15.3*	<0.01*	>99.9
4	0.220*	<0.01*	>95.4	4	5.40*	<0.01*	>99.8
4	52.0*	NA	NA	6	0.10*	0.009*	91.0
6	0.07	0.005	92.9	7	0.21*	0.021*	90.0
7	0.057*	0.16*	+	10	0.00103*	0.0347*	+
26	<0.050	<0.050	NA	13	1.4*	ND	NA
26	0.005*	ND*	NA	13	7.42*	<0.01*	>99.9
				25	<69.3	<9.6	86.1
				26	<0.20*	<0.20*	NA
				26	0.150*	0.005*	96.7

Chlorobenzene				Ethylbenzene			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	<0.005*	NA	NA	4	7.90*	ND	NA
4	3.0*	<0.01*	>99.7*	10	<0.001*	<0.001*	NA
4	135.0*	NA	NA	13	0.20	<0.01	>95.0
6	0.3*	0.76*	+				
9	ND*	ND*	NA				
13	3.80*	<0.01*	>99.7				
13	5.0*	<0.02*	>99.6				
26	ND*	ND*	NA				

NA = Not available
ND = Not detected
* = Data from comingled waste stream
+ = Concentration increased

Table VI-17. Biological Treatment Operating Preproposal Data (Continued, Page 6 of 13)

VOLATILE AROMATICS

1,2-Dichlorobenzene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.023*	<0.01*†	>56.5

1,3-Dichlorobenzene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.410*	0.013*	96.8

1,4-Dichlorobenzene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.470*	<0.01*†	>97.9

HALOMETHANES

Methyl chloride

Plant	Influent mg/l	Effluent mg/l	Percent Removal
6	ND	ND	NA
9	ND°	ND°	NA

Methylene chloride

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.260*	0.190*	26.9
7	0.55*	0.24*	56.4
9	<0.464*	<0.10*	78.4
10	<0.001*	0.172*	+
11	0.017*	0.020*	+
13	76.0*°	<1.1*	>98.5
26	0.030*	0.010*	66.7
26	<0.25*	0.100*	60.0

NA = Not available
ND = Not detected
* = Data from comingled waste stream
+ = Concentration increased
° = Analysis not conducted per protocol
† = Data from combined dichlorobenzenes: 1,2; 1,3; 1,4.

Table VI-17. Biological Treatment Operating Preproposal Data (Continued, Page 7 of 13)

HALOMETHANES (Continued)

	Chloroform				Carbon tetrachloride		
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	0.0149*	<0.01*	>32.9	4	1.00*	0.270*	73.0
4	0.022*	NA	NA	13	Trace	Trace	NA
4	0.120*	0.032*	73.3				
4	2.8	NA	NA				
6	0.017	<0.01	>41.2				
7	0.04*	0.06*	+				
7	0.20*	NA	NA				
9	<0.571*°	ND*	NA				
10	<0.001*	<0.001*	NA				
13	0.455*	<0.01*	>97.8				
13	0.867*	<0.01*	>98.8				
26	0.080*	0.020*	75.0				
26	<0.80	<0.30	62.5				

CYANIDE

	Cyanide		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	1.22*	0.682*	44.1
3	2.16*	0.337*	84.4
3	5.04	NA	NA
7	0.067*	0.065*	2.98
9	0.0959	0.071	26.0
13	0.92*°	0.404*°	56.1

NA = Not available
ND = Not detected
* = Data from comingled waste stream
+ = Concentration increased
° = Analysis not conducted per protocol

Table VI-17. Biological Treatment Operating Preproposal Data (Continued, Page 8 of 13)

HALOETHERS

	Bis(2-chloroethyl) ether		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
2	0.582	0.0527	90.9

PHENOLS

	Phenol		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	NA	0.004*	NA
1	0.058*	4.0*	+
4	0.290*	<0.01*	>96.5
4	16.0	NA	NA
4	16.0	NA	NA
4	47.0*	NA	NA
4	0.270*	0.042*	84.4
16	1100*	2.03*	99.8
21	61.8*	<3.84*	>93.8
28	0.01*	0.09*	+

	2-Chlorophenol		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.062*	<0.01*	>83.9
4	<0.5*	NA	NA

NA = Not available
* = Data from comingled waste stream
+ = Concentration increased

Table VI-17. Biological Treatment Operating Preproposal Data (Continued, Page 9 of 13)

PHENOLS (Continued)

2,4-Dichlorophenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.290*	0.018*	93.8
4	<5.0	NA	NA
4	15.0*	NA	NA
4	>1000	NA	NA
7	0.002*	NA	NA
7	0.042*	<0.001*	>97.6

2,4,6-Trichlorophenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.110*	0.180*	+
4	3.0*	NA	NA
4	<5.0	NA	NA
4	<100	NA	NA
7	0.022*	0.021*	4.54

Pentrachlorophenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.390*	0.230*	41.0
4	1.0*	NA	NA
4	>1000	NA	NA
21	0.58*	0.35*	39.6

4-Nitrophenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	ND	<0.01*	NA
5	203	10.7	94.7
5	174	<7.84	>95.5
6	461†	<1.0†	>99.8

2,4-Dinitrophenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
2	7.91	0.397	95.0

NA = Not available
ND = Not detected
* = Data from comingled waste stream
+ = Concentration increased
° = Analysis not conducted per protocol
† = Hydrolysis and biological oxidation treatment combined

Table VI-17. Biological Treatment Operating Preproposal Data (Continued, Page 10 of 13)

POLYNUCLEAR AROMATIC HYDROCARBONS

Naphthalene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.066*	<0.01*	>84.8

METALS

Copper

Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	0.204*	0.114*	44.1
4	0.510	0.110*	78.4
7	0.05*	0.06*	+
9	0.0575	0.112	+
9	0.093*	0.088	5.38
10	0.065	1.66*	+
13	0.53	0.30	43.4

Zinc

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.450*	0.400	11.1
7	0.06	0.13	+
10	<0.0257	0.187	+
13	0.530	0.120	77.4

Cadmium

Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	0.00723	0.0046	36.4
4	0.0021	0.0017	19.0
7	0.2	0.25	+
26	0.0003	0.0001	66.7
26	<0.00120	<0.00080	33.3

Chromium

Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	0.0647	0.044	32.0
4	0.240*	0.049*	79.6
7	1.0	1.1	+
10	0.060	0.033*	45.0
13	0.280	0.120	57.1
26	0.041	0.007	82.9
26	0.048*	0.008*	83.3
26	0.059	0.0075	>87.3

* = Data from comingled waste stream
+ = Concentration increased

Table VI-17. Biological Treatment Operating Preproposal Data (Continued, Page 11 of 13)

METALS (Continued)

Lead

Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	0.0489	0.0683	+
4	0.032*	0.0038*	88.1
7	0.003	0.003	0.0
7	0.065	0.018	72.3
13	0.011*	0.0048*	56.4
26	0.024	<0.001	>95.8
26	0.0243	<0.001	>95.9

Mercury

Plant	Influent mg/l	Effluent mg/l	Percent Removal
13	0.0008	<0.0004	>50.0

Nickel

Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	0.331	0.286	13.6
7	0.45	0.45	0.0
13	0.140	0.024	82.8

CHLORINATED ETHANES AND ETHYLENES

1,2-Dichloroethane

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	1.40*	0.580*	58.6
7	0.37*	0.18*	51.3
10	<0.0117*	<0.069*	+

1,1,1-Trichloroethane

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.430*	0.022*	94.9

* = Data from comingled waste stream
+ = Concentration increased

Table VI-17. Biological Treatment Operating Preproposal Data (Continued, Page 12 of 13)

CHLORINATED ETHANES AND ETHYLENES (Continued)

Vinyl chloride

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.023*	<0.01*	>56.5

1,1-Dichloroethylene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	1.10*	0.041*	96.3

1,2-trans-Dichloroethylene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.011*	<0.01*	>9.09*
7	0.17*	0.54*	+

Trichloroethylene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.034*	<0.01*	>70.6

Tetrachloroethylene

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.330*	0.037*	88.8
7	2.47*	1.45*	41.3
7	0.37*	6.9*	+

PHTHALATES

Bis(2-ethylhexyl) phthalate

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	<0.01*	0.028*	+

* = Data from comingled waste stream
+ = Concentration increased

Table VI-17. Biological Treatment Operating Preproposal Data (Continued, Page 13 of 13)

AMMONIA

	Tetrachloroethylene		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	7.24	4.4	39.2

Table VI-18. Plants Disposing All Pesticide Wastewaters by Contract Hauling*

Plant Code	Pesticide Code	Volume Disposed (MGD)	Pretreatment	Disposal Site/Method
1	A	0.01	NE,GS,KS,SP	City evaporation pond
	B	0.05	NE,GS,SK,SP	City evaporation pond
	C	0.06	MS,NE,GS,SK,SP	City evaporation pond
2	D	0.0163	NO	Sanitary landfill
3	E	0.00055	NE	Hazardous waste landfill
	F	0.00130	NE	Hazardous waste landfill
	G	0.00130	NE	Hazardous waste landfill
4	H	0.0000154	NE	Sanitary landfill
5	I	0.000086	NE	Sanitary landfill deep well injection
6	J	Nil	NO	Sanitary landfill deep well injection
7	K	0.0068	EQ,NE	Private waste treatment plant
8	L	0.000252	NO	Contract incinceration
9	M	0.0001	NE	Contract incineration
	M	NA	NO	Contract incineration
	N	0.0009	NO	Contract incineration
	O	0.0002	NO	Contract incineration
	P	0.005	NO	Contract incineration
	Q	NA	NO	Contract incineration
	R	0.0002	NO	Contract incineration
	R	NA	NO	Contract incineration

EQ = Equalization
GS = Garvity Separation
MS = Metal Separation
NA = Not Available
NE = Neutralization
NO = None
SK = Skimming
SP = Stripping
* = Proposal Data

Table VI-19. Plants Using Evaporation Ponds for Pesticide Wastewaters[1]

Plant Code	Pesticide Code	Volume Disposed (MGD)	Net Evaporation (Inches/Yr)	Supplementary Design	Pretreatment
1	A	0.02	-12	Heat	HD, NE, CO, EQ
	B	0.015	-12	Heat	HD, NE, CO, EQ
2	C	0.01	-12	Aeration	AL
	D	0.001	-12	Aeration	AL
3	E	0.0072	-2	None	GS, NE
4	F	0.091	+13	Heat	SK, AL
5	G	0.002	+20	NA	NO
6	H	0.001	+69	NA	NE

+ = Indicates precipitation is less than evaporation
AL = Aerated Lagoon
CO = Chemical Oxidation
EQ = Equalization
GS = Gravity Separation
HD = Hydrolysis
NA = Not Available
NE = Neutralization
NO = None
SK = Skimming
[1] = Preproposal Data

Table VI-20. Plants Disposing Pesticide Wastewaters by Ocean Discharge*

Plant Code	Pesticide Code	Flow (MGD)	Pretreatment
1	A	0.01009	None
	B	0.012	None
	C	0.005	None
	D	0.012	None
	E	0.008	None
	F	0.005	None

* = Preproposal Data

Table VI-21. Plants Using Deep Well Injection for Pesticide Wastewates*

Plant Code	Pesticide Code	Volume Injected (MGD)	Pretreatment
1	A	0.0072	NO
	B	0.0086	NO
	C	0.0720	NO
2	D	NA	GS
	D, H, I, and Q Combined Pesticide Processes	0.013	GS
	E	0.041	SE
	F	0.032	SE
	G	NA	NE
	H	NA	GS
	I	NA	GS
	J	NA	NE
	K	0.025	GS,NE
	L	0.0029	PF
	G, J, O, and P Combined Pesticide Processes	0.036	NE
	M	NA	NA
	N	0.010	NO
	O	NA	NE
	P	NA	NE
	Q	NA	GS
3	R	Nil	GS,MS,GS
	Pesticide intermediate	0.010	GS,MS,GS
4	S	NA	NO
5	T	0.0072	NE
	U	0.0072	NE
6	V	0.07	NE,PF
	W	0.08	NE,PF
7	X	0.30	NE,PF
8	Y	0.01	NE,CA,SK,GS,PF EQ

Footnote at end of table

Table VI-21. Plants Using Deep Well Injection for Pesticide Wastewates* (Continued, Page 2 of 2)

Plant Code	Pesticide Code	Volume Injected (MGD)	Pretreatment
9	Z	0.01	SK,GS,PF
	AA	0.04	SK,GS,PF,GS
	BB	0.04	SF,GS,PF,GS
	CC	0.04	SK,GS,PF,GS
	DD	0.01	SF,NE,GS,PF
	EE	0.04	SK,GS,PF,GS
	FF	0.04	SK,GS,PF,GS
	GG	0.01	SK,NE,GS,PF,GS
	HH	0.04	SK,GS,PF,GS
10	II	0.0015	AP
	JJ	0.015	AP
	KK	0.005	AP
11	LL	0.328	PF
12	MM	0.0072	NO
13	NN	0.00125	NO
14	OO	0.014	NE,GS,SE,GS,NE PF
15	PP	0.073	GS,PF
	QQ	0.0095	NE,GS,PF
16	RR	0.0533	GS,SK
17	SS	NA	NO
	TT	NA	NO

AP = API Type Separator
CA = Coagulation
EQ = Equalization
GS = Gravity Separation
MF = Multimedia Filtration
NA = Not Available
NE = Neutralization
NO = None
PF = Pressure Leaf Filter
SE = Solvent Extraction
SK = Skimming
* = Preproposal Data

Table VI-22. Treatment Technology Selected as Best Performance*

Treatment Unit	Number of Plant with Treatment BPT	 BAT
Biological Oxidation[1]	13	32
Chemical Oxidation[1]	-	9
Granular Activated Carbon[1]	9	17
Hydrolysis[1]	5	8
Metals Separation[1]	-	3
Resin Adsorption[1]	-	4
Steam Stripping[1]	-	8
Ion Exchange[2]	-	-
Membrane Processes[2]	-	-
Powdered Activated Carbon[2]	-	1
Solvent Extraction[2]	-	1
Ultraviolet Photolysis[2]	-	-
Wet Air Oxidation[2]	-	-

Note: 1 = Selected as best performance
2 = Not selected as best performance
* = Preproposal Data

Table VI-23. Total Plants with Data and Best Performance Plants[1]

Treatment	Plants with Data	Priority Pollutants
Activated Carbon	13	9
Biological Oxidation	18	12
Chemical Oxidation	1	0
Hydrolysis	8	6
Metals Separation	2	2
Resin Adsorption	4	4
Steam Stripping	5	3
Total	51	36

1 = Preproposal Data.

Table VI-24. Best Performance Removal Systems for Nonconventional Pesticides by Treatment Technology[1]

Treatment	Plant Criteria	Pollutant	BP Average Used
Activated Carbon	006 ≥95% Removal or <1 mg/l	2,4-D	Y >99.9%
Activated Carbon	008 ≥95% Removal or <1 mg/l	PCNB	Y >99.9%
Activated Carbon	022 ≥95% Removal or <1 mg/l	2,4-D	Y 99.9%
Activated Carbon	022 ≥95% Removal or <1 mg/l	Propachlor	Y 99.6%
Activated Carbon	006 ≥95% Removal or <1 mg/l	2,4-DB	Y >99.8%
Activated Carbon	206 ≥95% Removal or <1 mg/l	Carbendazim/ Benomyl	Y 99.6%
Activated Carbon	050 ≥95% Removal or <1 mg/l	Carbofuran	Y >99.6%
Activated Carbon	045 ≥95% Removal or <1 mg/l	Deet	Y 99.4%
Activated Carbon	039 ≥95% Removal or <1 mg/l	Trifuralin	Y 99.3%
Activated Carbon	018 ≥95% Removal or <1 mg/l	Dinoseb	Y 96.9%
Activated Carbon	036 ≥95% Removal or <1 mg/l	Triazines	Y 96.5%
Activated Carbon	022 ≥95% Removal or <1 mg/l	Atrazine	Y 96.2%
Activated Carbon	046 ≥95% Removal or <1 mg/l	Atrazine	Y 68% and <12.6 mg/l
Activated Carbon	049 ≥95% Removal or <1 mg/l	Bentazon	N 47% and 166 mg/l
Acitvated Carbon	203 ≥95% Removal or <1 mg/l	Dicofol	N 36% and 11 mg/l
Activated Carbon	006 ≥95% Removal or <1 mg/l	2,4-DOE	N N/A
Activated Carbon	198 ≥95% Removal or <4 mg/l	Dioxathion	N N/A
Hydrolysis	021 ≥95% Removal or <1 mg/l	Diazinon	Y 99.9%
Hydrolysis	028 ≥95% Removal or <1 mg/l	Parathion Methyl	Y >99.9%
Hydrolysis	028 ≥95% Removal or <1 mg/l	Parathion Ethyl	Y >99.9%
Hydrolysis	148 ≥95% Removal or <1 mg/l	Ethoprop	Y >99.9%

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[1] Preproposal

Table VI-24. Best Performance Removal Systems for Nonconventional Pesticides by Treatment Technology[1]

Treatment	Plant Criteria	Pollutant	BP Average Used
Hydrolysis	032 ≥95% Removal or <1 mg/l	Metribuzin	Y >99.8%
Hydrolysis	032 ≥95% Removal or <1 mg/l	Fensulfothion	Y >99.7%
Hydrolysis	032 ≥95% Removal or <1 mg/l	Phorate	Y 99.5%
Hydrolysis	032 ≥95% Removal or <1 mg/l	Fenthion	Y >98.3%
Hydrolysis	032 ≥95% Removal or <1 mg/l	Coumaphos	Y >98.3%
Hydrolysis	032 ≥95% Removal or <1 mg/l	Demeton	Y >98.0%
Hydrolysis	032 ≥95% Removal or <1 mg/l	Azinphos Methyl	Y >98.0%
Hydrolysis	032 ≥95% Removal or <1 mg/l	Disulfoton	Y >96.1%
Hydrolysis	027 ≥95% Removal or <1 mg/l	Parathion Methyl	Y >95.8%
Hydrolysis	032 ≥95% Removal or <1 mg/l	Bolstar	Y >95.0%
Hydrolysis	034 ≥95% Removal or <1 mg/l	Cyanazine	N >95.0%
Hydrolysis	198 ≥95% Removal or <1 mg/l	Didxathion	N 87.4%
Hydrolysis	034 ≥95% Removal or <1 mg/l	DBCP	N N/A
Hydrolysis	034 ≥95% Removal or <1 mg/l	Mevinphos	N N/A
Hydrolysis	034 ≥95% Removal or <1 mg/l	Naled	N N/A
Hydrolysis	034 ≥95% Removal or <1 mg/l	Stirofos	N N/A
Hydrolysis	034 ≥95% Removal or <1 mg/l	Dichlorovos	N N/A
Hydrolysis	148 ≥95% Removal or <1 mg/l	Merphos	N N/A
Resin Adsorption	229 ≥95% Removal or <1 mg/l	2,4-D	Y 97.0%
Activated Carbon	006 ≥99% Removal or <1 mg/l	2,4-Dichlorophenol	Y >99.9%
Activated Carbon	022 ≥99% Removal or <1 mg/l	2,4-Dichlorophenol	Y >99.9%
Activated Carbon	039 ≥99% Removal or <1 mg/l	N-Nitrosodi-N-Propylamine	Y 99.8%
Activated Carbon	008 ≥99% Removal or <1 mg/l	PCP	N 90.0%
Activated Carbon	039 ≥99% Removal or <1 mg/l	Phenol	N 33.3%

Table VI-24. Best Performance Removal Systems for Nonconventional Pesticides by Treatment Technology[1]

Treatment	Plant Criteria	Pollutant	BP Average Used
Activated Carbon	039 ≥99% Removal or ≤1 mg/l	PCP	N <0.01 mg/l
Activated Carbon	046 ≥99.0% Removal or ≤1 mg/l	N-Nitroso-Di-N Propylamine	N ND
Activated Carbon	046 ≥99.0% Removal or ≤1 mg/l	Phenol	N ND
Resin Adsorption	003 ≥99.0% Removal or ≤1 mg/l	Toxaphene	Y 99.3%
Resin Adsorption	023 ≥99.0% Removal or ≤1 mg/l	Hexachloro-cyclopentadiene	Y (92.2%) 0.078 mg/l
Resin Adsorption	023 ≥99.0% Removal or ≤1 mg/l	Endrin	Y (97.1%) <0.015 mg/l
Resin Adsorption	023 ≥99.0% Removal or ≤1 mg/l	Heptachlor	Y (96.9%) 0.24 mg/l
Resin Adsorption	229 ≥99.0% Removal or ≤1 mg/l	2,4-Dichlorophenol	Y (93.9%) <0.492 mg/l
Chemical Oxidation	034 ≥99.0% Removal or ≤1 mg/l	Cyanide	N 96.6%
Metals Separation	010 ≥95.0% Removal or ≤0.50 mg/l	Copper	Y 99.9%
Metals Separation	050 ≥95.0% Removal or ≤0.50 mg/l	Zinc	Y (63.8%) <0.12 MS
Steam Stripping	049 ≥90.0% Removal or ≤5 mg/l	Dichlorobenzene	Y 97.8%
Steam Stripping	229 ≥90.0% Removal or ≤5 mg/l	Toluene	Y 95.0%
Steam Stripping	010 ≥90.0% Removal or ≤5 mg/l	Chloroform	Y >92.9%
Steam Stripping	006 ≥90.0% Removal or ≤5 mg/l	Benzene	Y (42.8%) <0.04 mg/l
Steam Stripping	006 ≥90.0% Removal or ≤5 mg/l	Toluene	Y (42.1%) <0.04 mg/l
Steam Stripping	006 ≥90.0% Removal or ≤5 mg/l	Methylene Chloride	N 99.9%
Steam Stripping	006 ≥90.0% Removal or ≤5 mg/l	Chloroform	N 98.4%
Steam Stripping	006 ≥90.0% Removal or ≤5 mg/l	Carbon Tetra-chloride	N <0.001 mg/l
Steam Stripping	034 ≥90.0% Removal or ≤5 mg/l	Ammonia	N N/A

Table VI-24. Best Performance Removal Systems for Nonconventional Pesticides by Treatment Technology[1]

Treatment	Plant Criteria	Pollutant	BP Average Used
Steam Stripping	206 ≥90.0% Removal or ≤5 mg/l	Ammonia	N N/A
Steam Stripping	229 ≥90.0% Removal or ≤50 mg/l	Benzene	N <0.299 mg/l
Biological Oxidation	048 ≥95% Removal or ≤ 50 mg/l	BOD	Y 98.8%
Biological Oxidation	041 ≥95% Removal or ≤50 mg/l	BOD	Y 98.3%
Biological Oxidation	034 ≥95% Removal or ≤50 mg/l	BOD	Y >95.6%
Biological Oxidation	021 ≥95% Removal or ≤50 mg/l	BOD	Y 95.0%
Biological Oxidation	019 ≥95% Removal or ≤50 mg/l	BOD	Y (91.4%) 27.1 mg/l
Biological Oxidation	022 ≥95% Removal or ≤50 mg/l	BOD	Y (93.3) 8.0 mg/l
Biological Oxidation	028 ≥95% Removal or ≤50 mg/l	BOD	Y 12.7 mg/l
Biological Oxidation	206 ≥70% Removal or ≤586 mg/l	COD	Y (87.4%, 114 mg/l BOD) 84.2% COD
Biological Oxidation	180 ≥70% Removal or ≤586 mg/l	COD	Y 82%
Biological Oxidation	032 ≥70% Removal or ≤586 mg/l	COD	Y (92.1%, 73.8 mg/l BOD) 70.0% COD
Biological Oxidation	027 ≥95% Removal or ≤50 mg/l	BOD	N 57.9% 1820 mg/l BOD 65.2%, 3340 mg/l COD
Biological Oxidation	146 ≥95% Removal or ≤50 mg/l	BOD	253 mg/l
Biological Oxidation	020 ≥95% Removal or ≤50 mg/l	BOD	N N/A
Biological Oxidation	039 ≥95% Removal or ≤50 mg/l	BOD	N N/A
Biological Oxidation	200 ≥95% Removal or ≤50 mg/l	BOD	N N/A

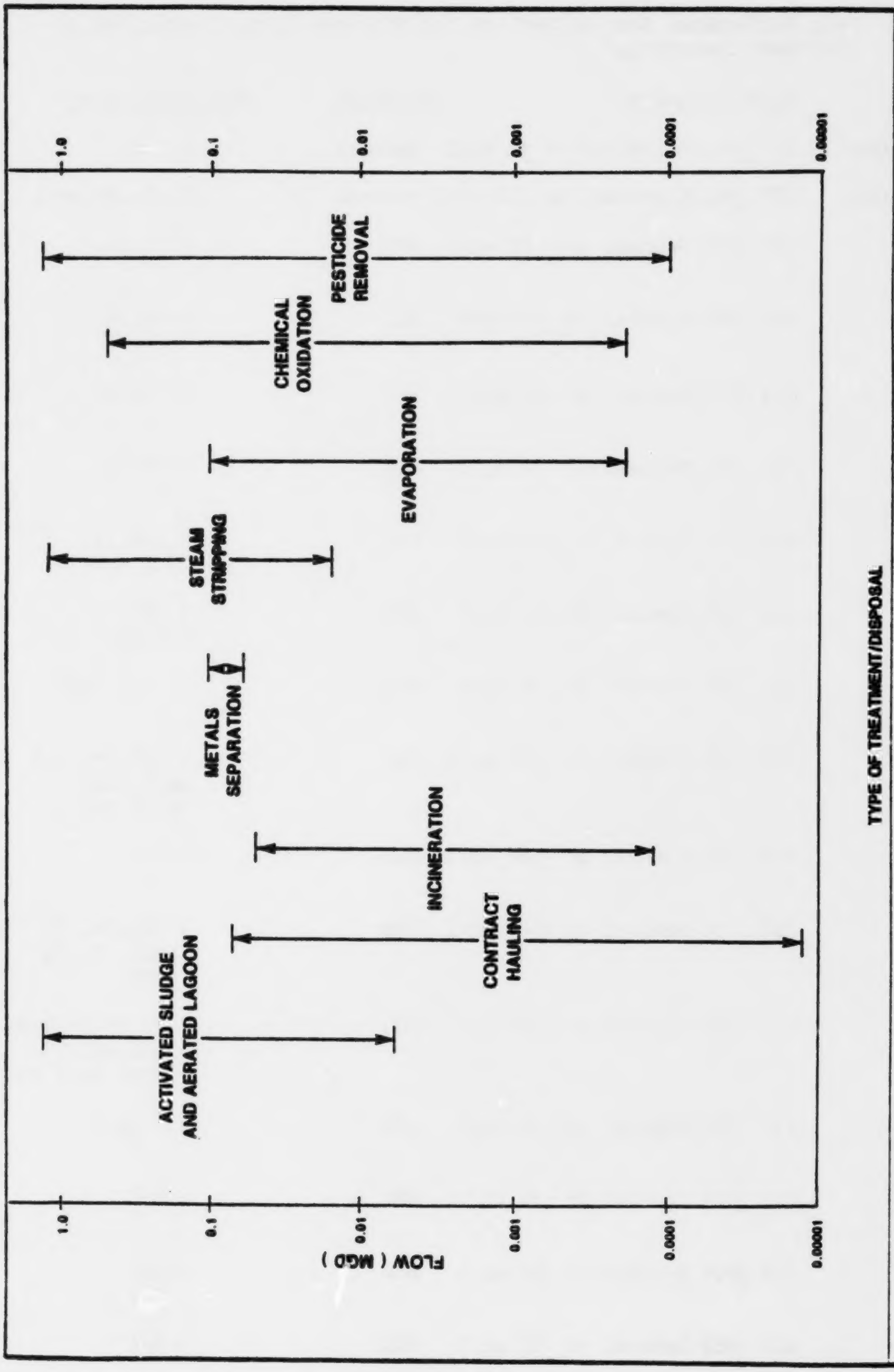


FIGURE VI-1 RANGE OF FLOWS FOR PESTICIDE TREATMENT/DISPOSAL

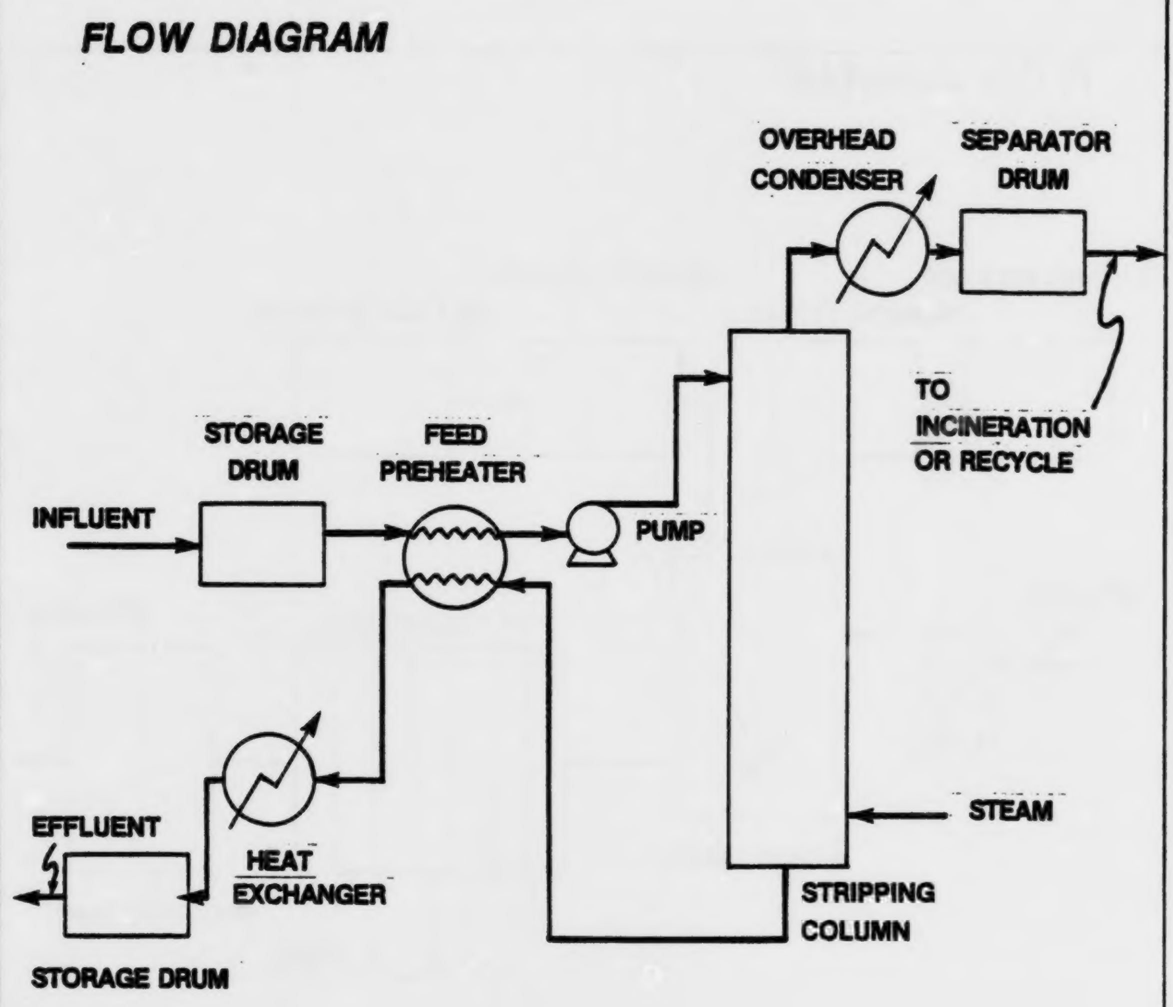


Figure VI-2 RECOMMENDED BAT TECHNOLOGY STEAM STRIPPING

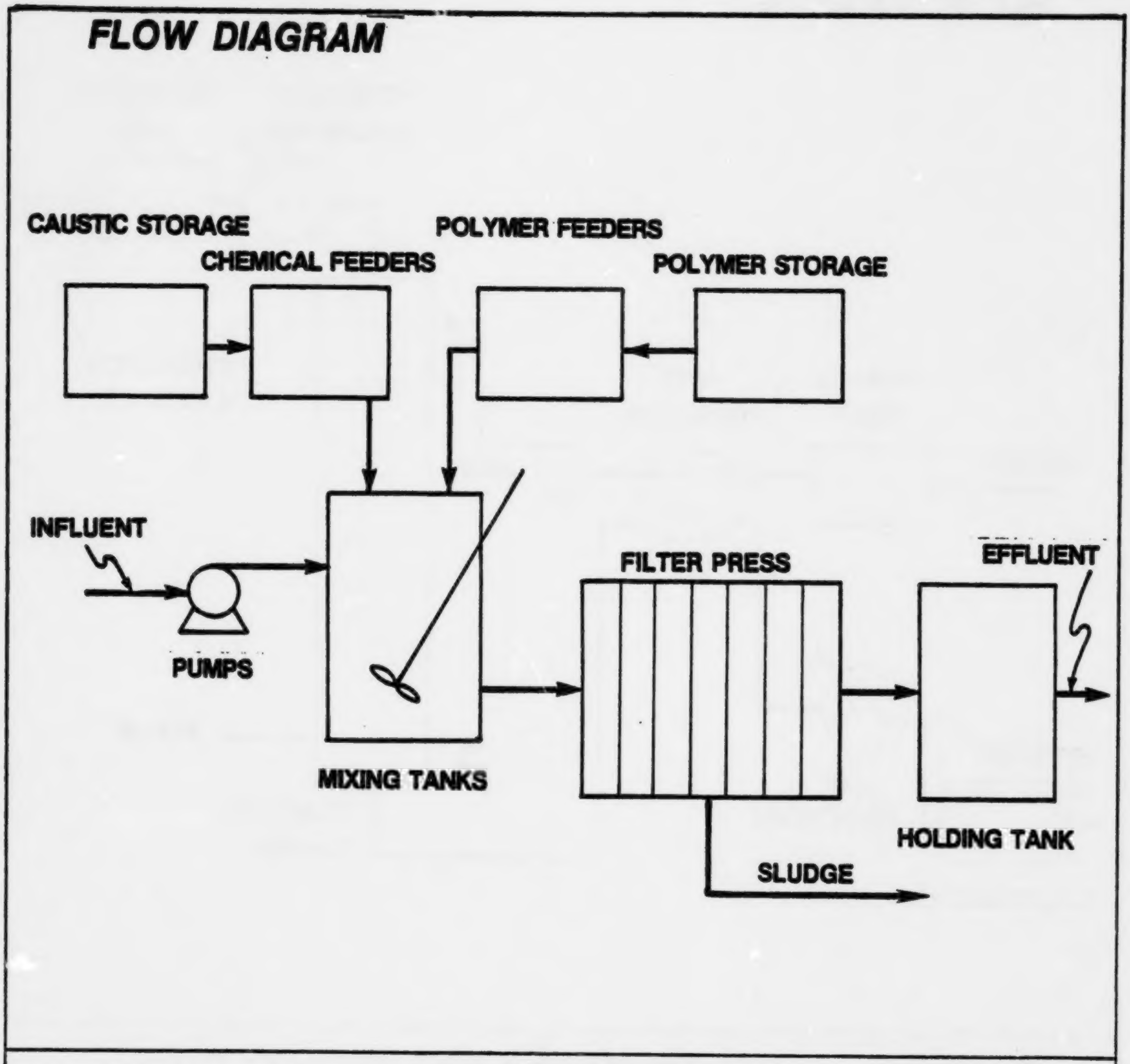


Figure VI-3 RECOMMENDED BAT TECHNOLOGY
METALS SEPARATION

FLOW DIAGRAM

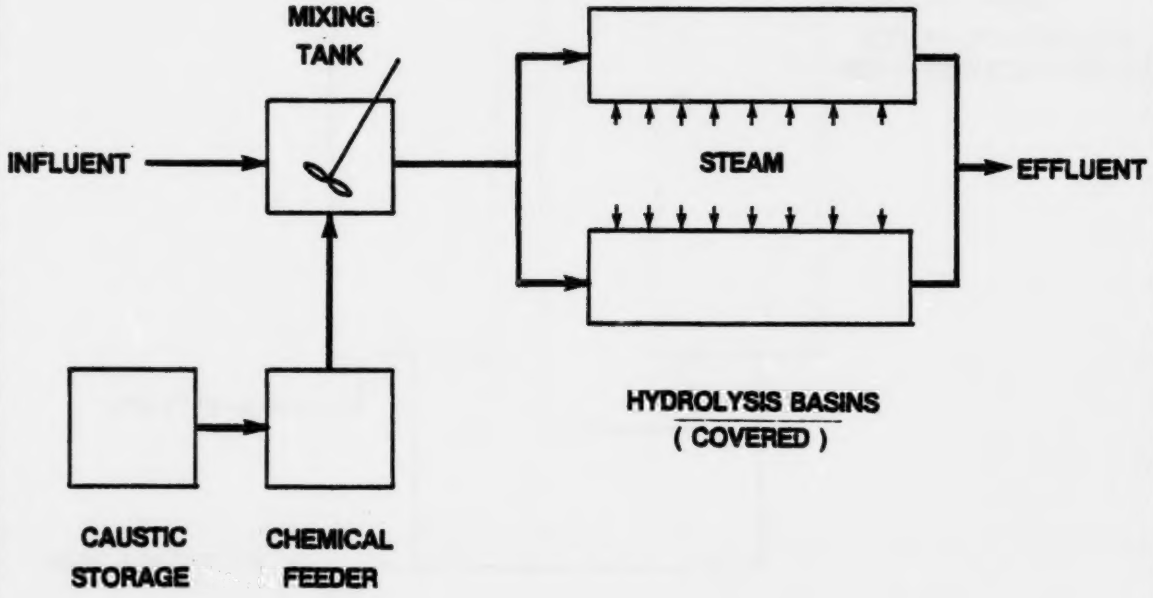


Figure VI- 4 RECOMMENDED BAT TECHNOLOGY
PESTICIDE HYDROLYSIS

FLOW DIAGRAM

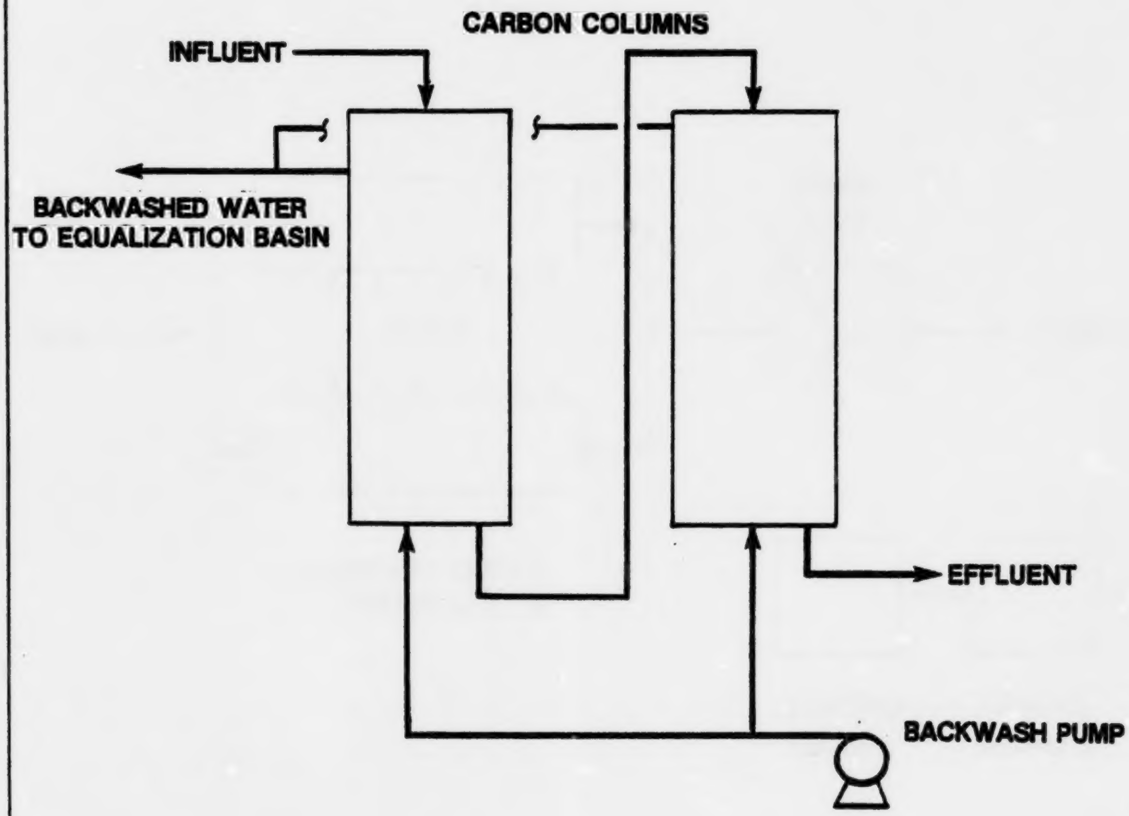


Figure VI- 5 RECOMMENDED BAT TECHNOLOGY CARBON ADSORPTION

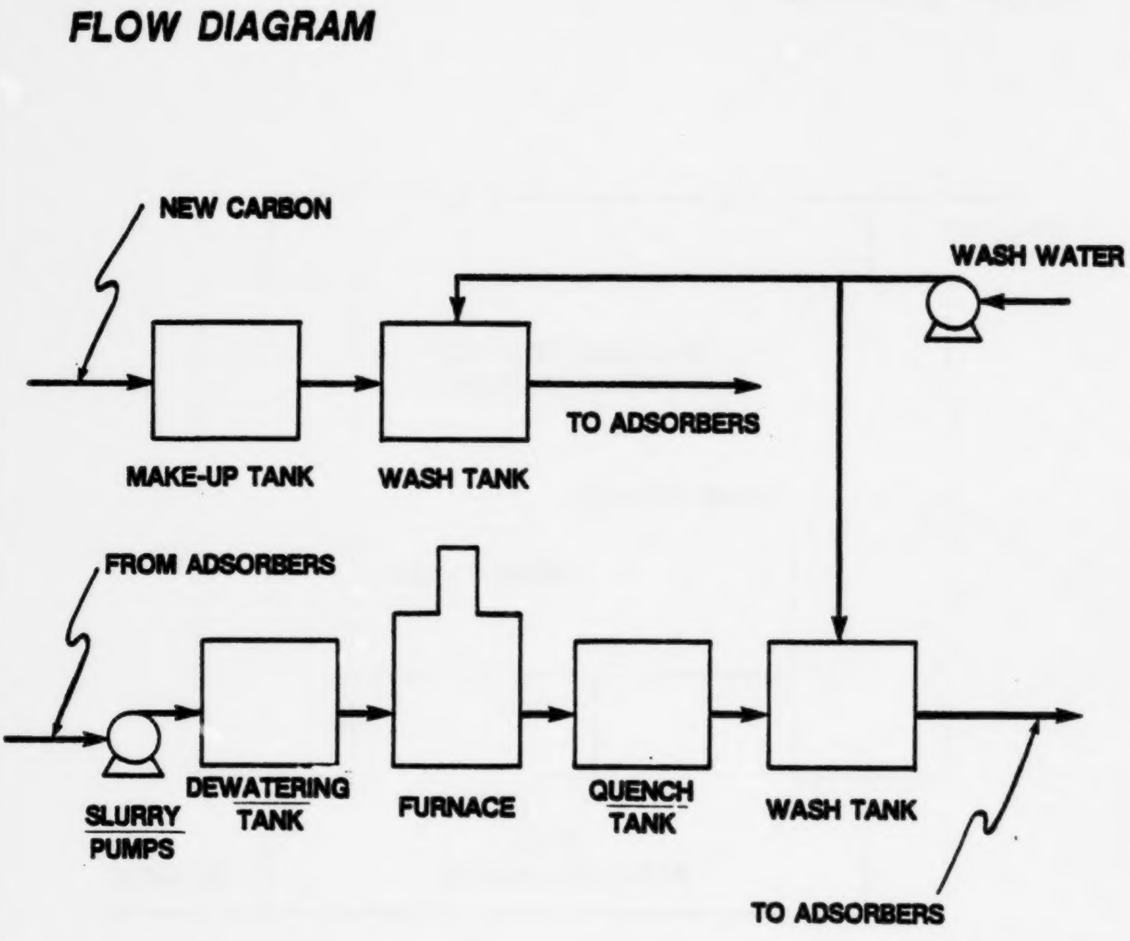


Figure VI- 6 RECOMMENDED BAT TECHNOLOGY
CARBON REGENERATION

FLOW DIAGRAM

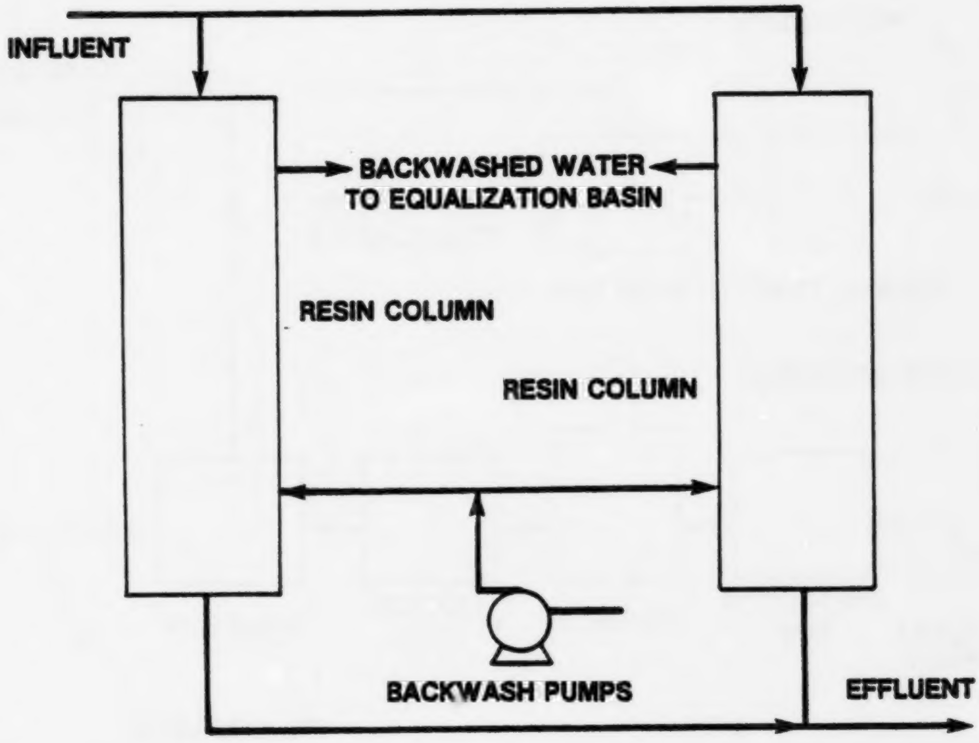


Figure VI- 7 RECOMMENDED BAT TECHNOLOGY RESIN ADSORPTION

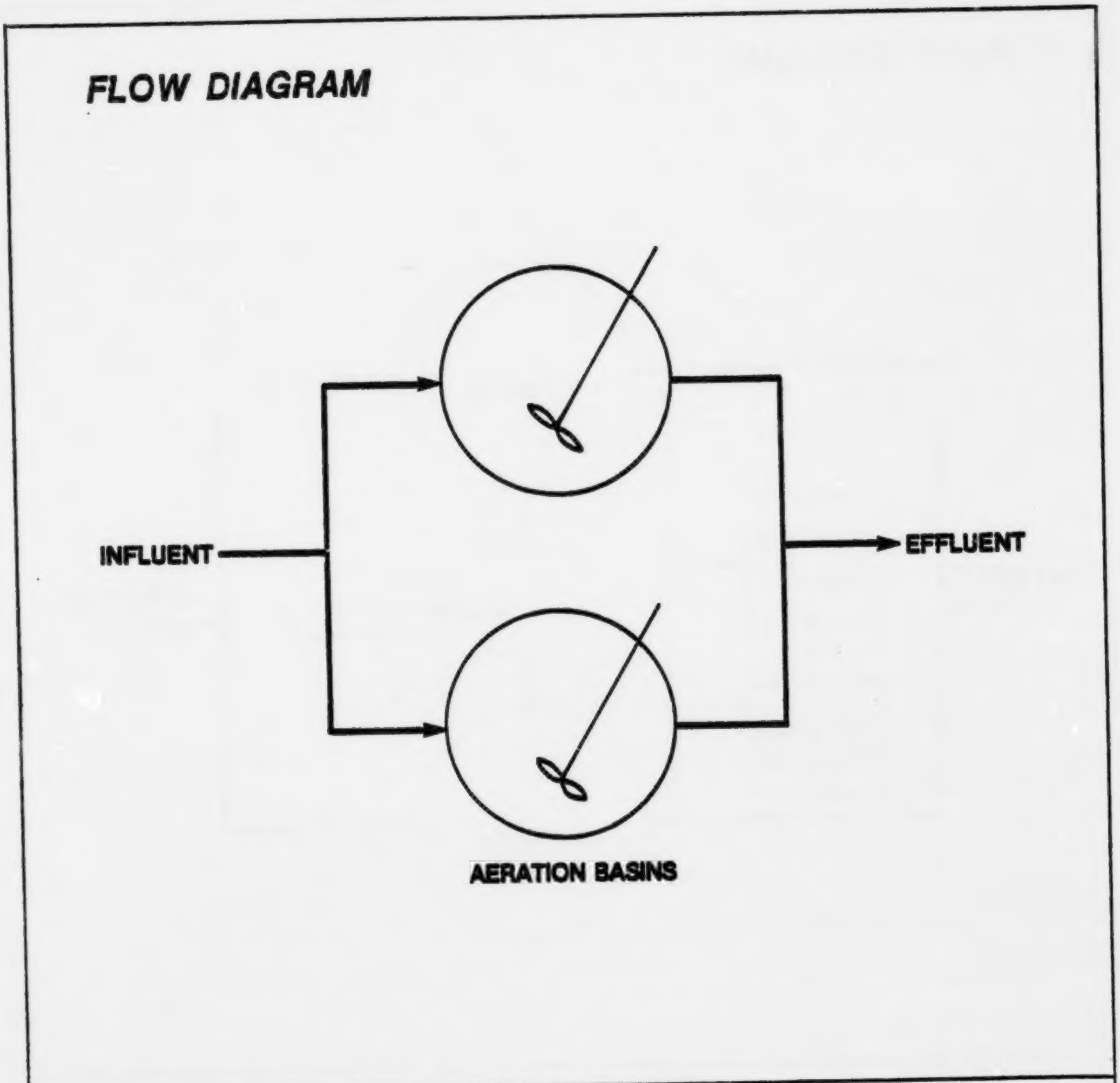


Figure VI- 8 RECOMMENDED BAT TECHNOLOGY
AERATION BASIN

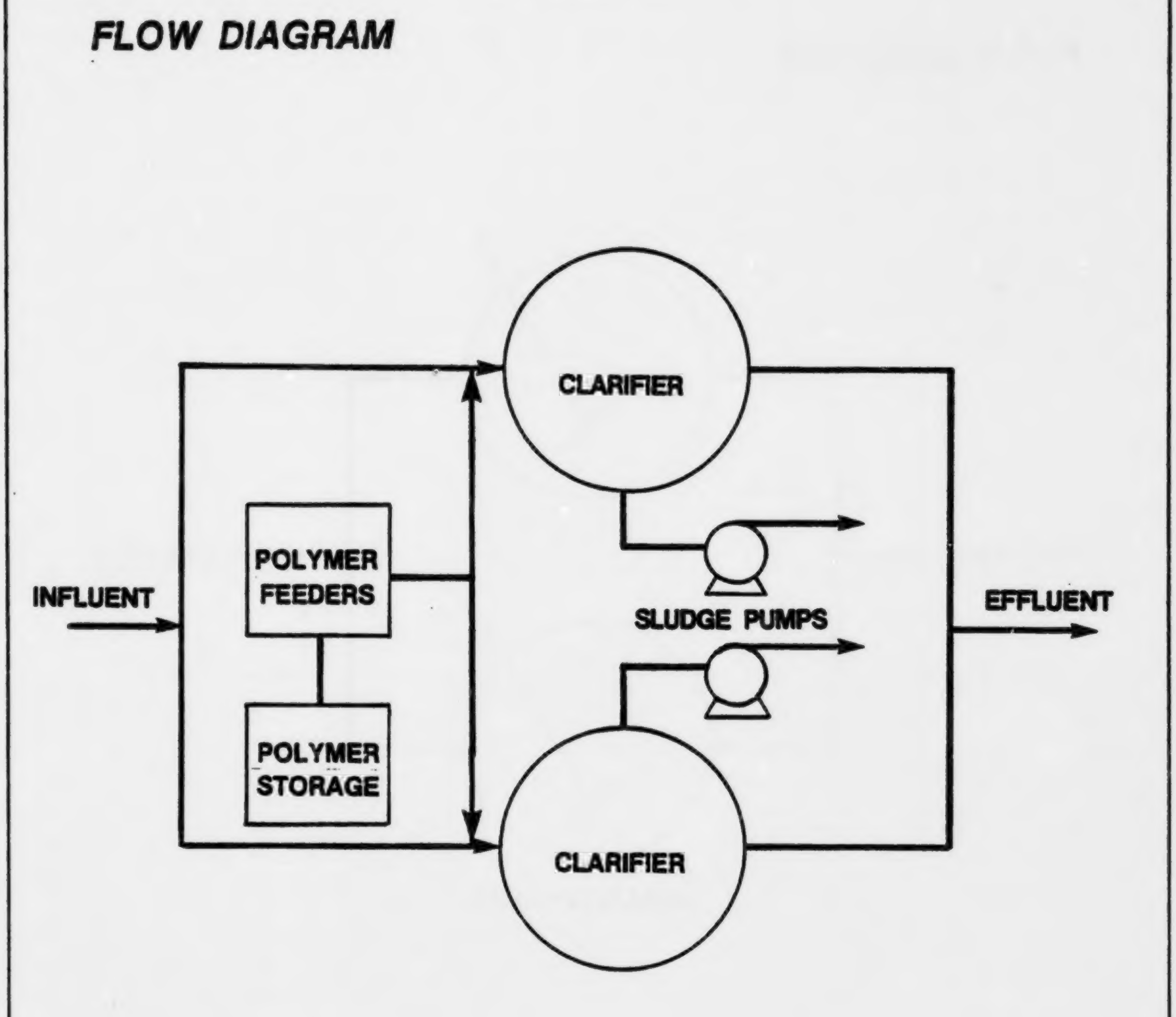


Figure VI- 9 RECOMMENDED BAT TECHNOLOGY CLARIFICATION

FLOW DIAGRAM

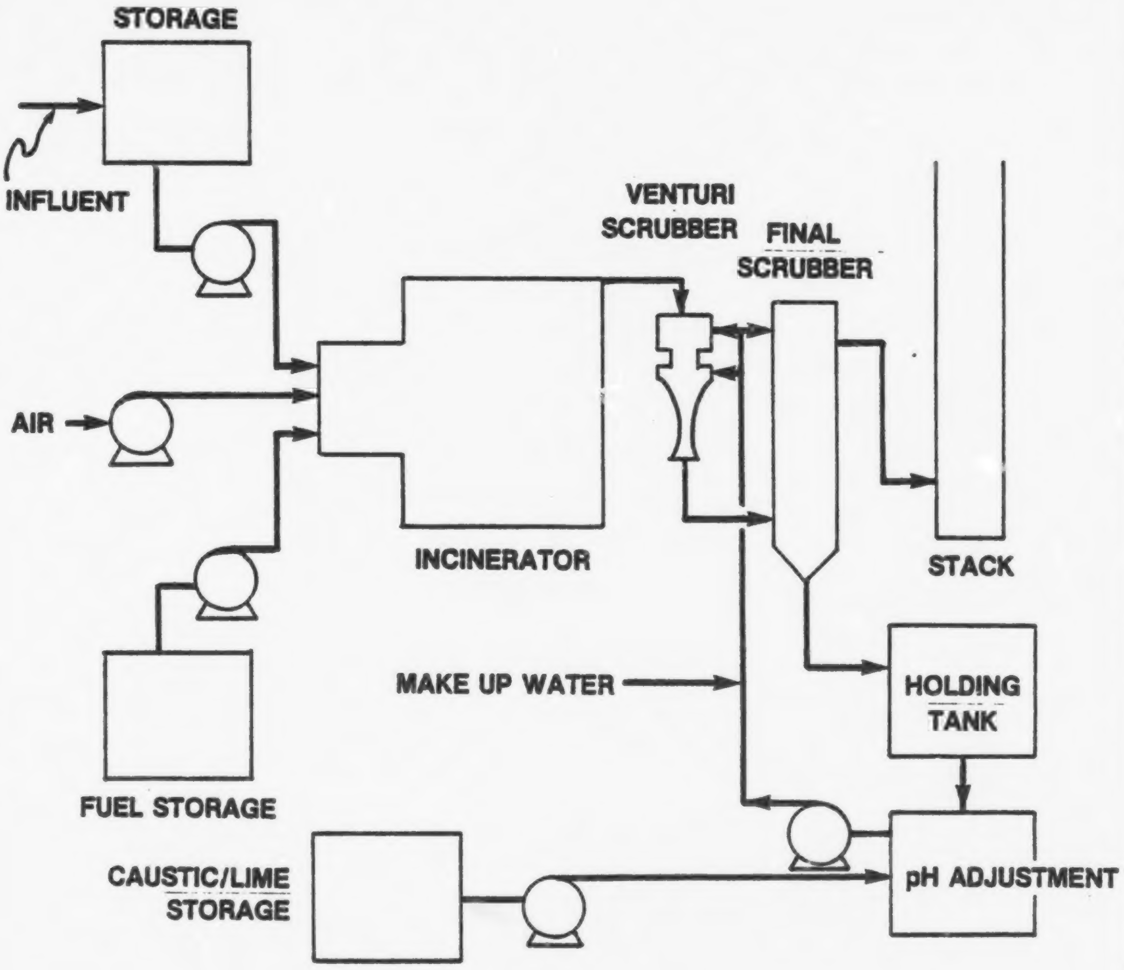


Figure VI- 10 RECOMMENDED BAT TECHNOLOGY INCINERATION

SECTION VII

INDUSTRIAL SUBCATEGORIZATION

INTRODUCTION

The primary purpose of industry subcategorization is to establish groupings within the Pesticides Chemicals Category such that each group (subcategory) has a uniform set of effluent limitations. This requires that the elements of each group be capable of using similar treatment technologies to achieve the effluent limitations. Thus, the same wastewater treatment and control technology is applicable within a subcategory and a uniform treated effluent results from the application of a specific treatment and control technology. This section presents the subcategorization established for the Pesticides Chemicals Category and explains the selection rationale.

Proper industry subcategorization defines groups within an industrial category whose wastewater discharges can be contolled by the same concentration or mass based limitations. The subsections which follow deal with these considerations as they apply to the Pesticides Chemicals Category.

CATEGORIZATION BASIS

The following aspects of the Pesticides Chemicals Category were considered for the bases of establishing subcategories:

1. Product type
2. Manufacturing process
3. Raw materials
4. Dominant Product
5. Geographic location
6. Plant size
7. Plant age
8. Non-water quality characteristics
9. Treatment cost
10. Energy cost

After examination of the potential categorization bases, three pesticides subcategories were established. These are:

Subcategory 1 - Organic pesticide chemical manufacturers

Subcategory 2 - Metallo-organic pesticide chemical manufacturers of mercury, cadmium, copper, and arsenic - based products

Subcategory 3 - Formulator/packagers of pesticide chemicals

The primary bases for subcategorizing plants in this industry were found to be dominant product type, manufacturing processes, and raw materials used.

Product Type

Product type is the primary difference between organic pesticide manufacturers and metallo-organic pesticide manufacturers. In the manufacture of organic pesticides, metals may be used as catalysts but are not a component of the end product. Metal atoms are significant components of metallo-organic pesticides. Because of the product difference, raw waste characteristics are also different, because the process wastewater from metallo-organics pesticide chemicals would contain large concentrations of metals, whereas the process wastewater from organic pesticide chemicals would not.

Manufacturing Process

Typically, organic pesticide chemicals and metallo-organic pesticide chemicals are manufactured for captive or merchant use in four or more chemical reaction steps starting from raw material to final product. Two or more different products might use the same process but then the raw materials used, process sequence, control, recycle potential, handling, and quality control will vary, producing wastes of different quality.

Pesticide chemicals formulating and packaging is a physical mixing of a finished pesticide active ingredient with an inert material and the subsequent packaging of that mixture for sale. Any chemical reaction that might occur are coincidental. Hence, pesticide chemicals formulating and packaging process is significantly different from the organic and metallo-organic chemicals manufacturing processes. Therefore, manufacturing process is used as a basis for subcategorization.

Raw Materials

The different products are produced from different raw materials, but the primary difference is that metallo-organic pesticide chemicals have metallic compounds as raw materials, whereas organic pesticide chemicals do not. This difference leads to differences is raw waste characteristics, and is essentially a consequence of the different product types.

Geographical Location

Pesticide chemical plants exist in all parts of the United States but subcategorization on this basis is not appropriate. Geographical location is important in analyzing the feasibility of various treatment alternatives. Evaporation ponds are functional only in areas where evaporation exceeds rainfall. Ocean dumping and deep well disposal are possible only in certain areas, and must be consistent with local, state and federal laws. The possibility of ground water contamination may preclude the use of unlined holding and settling ponds in many locations.

In the northern regions, climatic conditions may necessitate the inclusion of special provisions to prevent freezing of treatment system components, particularly biological oxidation units, clarifiers, ponds, and open collection systems. The costs of utilizing waste heat sources from the process or providing various types of thermal protection, such as insulation or burial of pipes and tanks and building structural shelters, may add considerably to the capital and O&M cost associated with a treatment technology.

Thus, the influence of geography, climate, geology, etc., is reflected in wastewater treatment modifications and is primarily manifested in the cost of treatment. This, of itself, is not a good basis for subcategorization.

Dominant Product

Subcategorization by chemical name of the dominant chemical produced involves the least ambiguity in applying standards to a given point source. There is great variety of product mix, manufacturing processes, wastewater constituents, and other factors at existing plants. Subcategorization by product becomes less useful as product mix increases in complexity because multi-product wastewater also becomes more complex and less susceptible to simple uniform treatment.

A subcategory established on the basis of product manufactured might have two or more different processes but, in the majority of cases, the characteristics of the wastewaters should be similar and the same treatment technology can be applied for different process wastewaters. In the pesticide chemicals category, there are a very large number of products produced, but most are produced at only one or two plants. Hence, subcategorization based on product would yield a large number of subcategories, most with only one or two plants. This would be a very complex regulatory approach.

The Agency, at proposal, attempted an alternate approach where the dominant products were grouped together based on similar pollutants in the untreated wastewater. However, this approach was found to be needlessly complicated and unnecessary because the Agency found that it could apply a uniform approach to developing regulations based on a general model treatment system for each product type (organic or metallo-organic pesticide) while incorporating the flexibility needed for the different dominant products within each product type. Hence, the subcategorization is not based on dominent product.

Plant Size

Plant size and production capacity were not found to affect the characteristics of the wastewater produced. Although plant size can affect treatment cost, this variability can be expressed graphically or mathematically without the need for further segmentation of the category.

Plant Age

Plant age can have an important bearing on wastewater volume and quality and is, therefore, a significant factor to consider in evaluating the applicability of treatment technologies and assessing the relative costs of treatment for plants of widely differing age producing the same or similar products. A particular problem with older plants is that their present patterns of water use may have evolved over a long period of time with little consideration for the principles of efficient waste segregation, collection, and treatment. To a limited degree, plant modernization can correct or at least mitigate some of these shortcomings in older facilities, however, only a small proportion of the cost of revamping collection systems or of converting from contact to noncontact cooling systems can be offset by the resulting lower cost of treatment. In general, older plants, even after considerable modernization, normally have a higher volume of wastewater flow and higher waste loadings (although pollutant concentrations may be lower due to poor segregation from noncontact sources) in comparison to relatively new plants. Pollution control requirements could impose a severe treatment cost penalty on older plants due to the need for backfitting and replumbing of outdated collection systems. Land availability and land use restrictions are also factors which may translate into higher treatment costs for older facilities which find themselves surrounded by highly developed industrial and residential areas.

Unfortunately, plant age does not readily lend itself to an unambiguous definition where a series of plant modifications has taken place. The extent of modifications also varies greatly among plants within the same product industry. For those plants that have been enlarged or modified from their original status, plant age is not unambiguously calculable and therefore is not a reasonable basis for subcategorization.

Non-Water-Quality Characteristics

Airborne emissions from manufacturing operations can be kept within air quality control limits through the use of cyclones, wet scrubbers and other methods. The nature of the air pollution is related to the product(s) manufactured and/or the raw material used. As discussed in Chapter VI, most metals, including arsenic, cadmium, and copper, can be incinerated with the metal bearing ash safely collected, because neither the metal nor its metal oxide incineration products are volatile. Hence, the metal-bearing ash is collected by scrubbers, cyclones, or other air pollution control device. By contrast, mercury is a volatile metal, hence incineration of process wastewater from mercury-organic pesticide manufacturing could result in release of the mecury to the environment through the incinerator exhaust. Therefore, the metallo-organic pesticide chemicals subcategory was further subdivided into two segments.

The pretreatment standard for the mercury organic pesticide chemical manufacturing segment is different from the standards for the arsenic, cadmium, copper organic pesticide chemical segment. Although the Agency did not subcategorize on the basis of non-water-quality characteristics, the non-water quality characteristics are reflected in the varying pretreatment standards.

Treatment Cost

From a technical viewpoint, subcategorization by common technological requirements for treatment processes could provide a logical basis for selecting one or more unit processes to accomplish the same treatment function, regardless of the source of the wastewater. This "building block" concept could conceivably result in selecting various combinations of unit processes to meet the treatment requirements. However, this method of subcategorization crosses product lines and product types. Even if the unit operation is commonly applicable for treating wastewater flows of different products, the cost of treatment will fluctuate because of variations in wastewater quality, loading and flow rates, and subcategorization on the basis of treatment cost is not recommended.

Energy Cost

The energy costs for treatment are related to the product type and treatment costs. Manufacturing processes in the organic pesticide chemicals industry typically have large energy requirements. In contrast, wastewater treatment processes consume a small fraction of the total energy used. There appears to be no major energy requirements for wastewater treatment facilities. By contrast, in the metallo-organic pesticide chemical (except mercury organic pesticide chemicals segment) and pesticide chemicals formulating and packaging subcategories, the cheapest technology for most plants in contract hauling and incineration which does involve energy costs. When balanced against other costs, however, these costs are less than the costs of any other treatment technology. Therefore, subcategorization on the basis of energy cost is not justified.

SECTION VIII

COST, ENERGY, AND NONWATER QUALITY ASPECTS

The purpose of this section is to document the cost, energy, and nonwater quality aspects of recommended treatment technology presented in Section VI.

COST AND ENERGY

Pesticide Manufacturers

The costs presented in this section are estimates of the capital, annual, and energy expenses which could potentially be incurred to meet the design effluent levels presented in Sections XI and XIII for pesticide manufacturers. These estimates are therefore the incremental costs above and beyond BPT.

The general costing analysis methodology is outlined as follows:

a. Development of treatment technology cost curves

b. Evaluation of the characteristics of each individual waste stream for each manufacturing plant

c. Determination of pollutants removal percent requirements based upon effluent monitoring data and the proposed effluent long-term average limitations

d. Selection of treatment technologies

e. Determination of treatment technology costs

f. Determination of monitoring costs

g. Determination of compliance costs associated with Resource Conservation and Recovery Act (RCRA) requirements.

The costs presented here represent the expenditures which would be required to treat detected and indicated priority, conventional, and nonconventional pollutants. The plant-by-plant treatment cost estimates were based on the following criteria.

1. For those plants with effluent data exceeding BAT levels for priority pollutants and for pesticides projected treatment to bring the plant into compliance with the appropriate regulation was costed.

2. For those plants without effluent data, it was assumed that pollutants germane to each process exist at effluent levels in excess of the design levels and appropriate treatment was costed accordingly.

3. Plant waste streams requiring similar treatment were assumed to use common treatment units.

4. Pesticide costs were based on individual pesticide wastestream flow data. Where individual wastestream flow was unavailable, the total plant flow was assumed for costing.

It should be noted that treatment cost estimates may in some cases be overestimated due to such factors as:

1. Treatment costs for large activated carbon facilities were based on the purchase of the activated carbon system and regeneration facilities. This is more expensive than the leasing of activaed carbon systems which is prevalent inthe industry.

2. Contract hauling has been costed to handle hazardous waste. Disposal costs may be cheaper if wastes are determined to be nonhazardous.

The Agency does not require that these recommended BAT or PSES technologies be installed at any plant location; however, the application of these technologies will attain the design effluent levels. Individual plants have the option of utilizing process modifications, in-plant controls, alternate methods of disposal, alternate end-of-pipe treatment units, or any combination of the above in order to achieve equivalent effluent levels. A plant-by-plant cost analysis has been conducted in order to assess the potential economic impact of installing the recommended treatment to meet design effluent levels. This analysis is confidential and is in a separate section of the record. The procedure is in Economic Impact Analysis of Effluent Limitations Guidelines and Standards for the Pesticide Chemical Industry, EPA-440/2-85-027, September 1985.

The cost estimates for pesticides manufacturers are presented on a plant-by-plant basis. They show the costs potentially incurred by model plants of various flows and differing pesticide treatability. They were derived in he following manner:

1. Costs were generated for each treatment unit specified in Section VI based on August 1983 dollars and corresponding to a Marshall and Swift Index value of 592. The capital and annual

cost assumptions for these computations are presented in Tables VIII-1 and VIII-2. The basis for these assumptions is documented in Supplement B to the Administrative Recrod for the regulation. The total construction costs for each unit were prepared from equipment manufacturers' estimates which were compared to actual plant data when available. The total construction costs include the treatment unit cost, land, electrical, piping, instrumentation, site preparation, engineering, and contingency fees. Annual and energy costs were calculated in accordance with the assumptions specified. Cost curves were prepared for dollars versus volume treated, and each of the components included in the individual treatment units was specified. These cost curves are presented graphically in Figures VIII-1 through VIII-19.

2. A summary of the plant-by-plant treatment technology costs is presented in Table VIII-3. The total capital, land, annual and energy costs for each plant were derived by summing the costs for individual treatment units that are specified for each level of control recommended in Sections XI thru XIV.

Each plant in subcategory one has been costed and evaluated for their ability to incur incremental monitoring costs associated with these regulations. The Agency assumed plants would monitor for priority pollutants and nonconventional pesticides one per week as a cost of $1,125. The annual cost for monitoring is $54,000 per plant. However, the summary costs for subcategory one only include the monitoring costs for the 42 direct and indirect plants incurring other treatments costs as a result of this regulation. In addition, nine subcategory one plants were costed based on the requirements under the Resource Conservation and Recovery Act (RCRA).

Summary Cost

	Annual	Capital
Treatment Costs	49.712	105.18
RCRA Costs	.453	
Monitoring Costs	2.189	
Total Costs	52.354	105.18

The cost of compliance with the regulation also includes plant-by-plant costs for monitoring and costs associated with requirements under the Resource Conservation and Recovery Act (RCRA).

Metallo-Organic Pesticide Manufacturers

For the Metallo-Organic Pesticide manufacturers, the Agency is promulgating a no discharge of pollutants standard for PSES except for manufacturers of mercury-based metallo-organic pesticides. The pretreatment standard for mercury would affect one facility that manufactures mercury metallo-organic compounds. This one facility has a discharge of approximately 3,000 gallons per day of untreated process wastewater containing an average of approximately 2,000 mg/l of mercury. This facility currently has a pilot plant pretreatment system using zinc oxide precipitation that is demonstrating 99.99 percent removal. The Agency is basing the regulation for mercury on this plants treatment system (see Section VI). The estimated capital, annual O&M and total annual costs for mercury waste treatment for this specific plant are approximately $47,000, $119,550 and $129,800, respectively. Although residual zinc may appear in the effluent, the Agency is excluding zinc from regulation under paragraph 8(a)(i) of the Settlement Agreement because only one facility is affected.

For the plants that are required to achieve no discharge of detectable amounts of pollutants contract hauling and incineration, is recommended. Typical cost ranges for contract hauling are presented in Table VIII-4.

Pesticide Formulator/Packagers

The costs presented in this section are estimates of the capital and annual expenses which could potentially be incurred to meet the no discharge requirements for pesticide formulator/packagers. Plant-by-plant costs were developed for a set of randomly selected formulator/packagers. These costs were then extrapolated to the estimated total number of formulating/packaging plants. Discussed here are (1) costs for low flow plants, (2) costs for high flow plants and (3) the extrapolation of costs to the universe of formulator/packagers.

1. EPA received 40 questionnaires from the industry which contained sufficient information to provide a means of correlating specific information with flow data. This data included plants that were not randomly selected but volunteered information to EPA. Several of the 40 plants were contacted by EPA so that site-specific anomalies could be evaluated. Four plants discharge wastewater volumes that were over 1,000,000 gallons per year while the remaining plants typically discharge less than 200,000 gallons per year. The high flow plants tend to use proportionally more water as a solvent, produce more product lines, and operate more weeks per year. Lack of economies of scale favor contract hauling as the method of achieving zero regulated pesticide pollutant discharge at the low flow plants.

Wastewater treatment and reuse is a demonstrated means of achieving zero discharge at both low and high flow plants.

Compliance costs were calculated for each of the 40 formulator/packagers that submitted a questionnaire and is currently an indirect discharger. Plants that discharged pesticide-bearing waste streams less than 200,000 gallons per year were costed differently than the 4 plants that discharge higher flows. Contract hauling and incineration was the technology selected for the low flow plants. Capital and annual costs are based on the cost of low volume waste stream segregation, collection, storage, contract hauling and segregation, collection, storage, contract hauling and incineration. Segregation, collection, and storage costs are estimated below for a typical low flow formulator/packager. This system would be installed in addition to existing systems. The existing systems would be used to collected unregulated waste streams, such as sanitary wastes. Piping costs are tripled to reflect the cost of retrofit. Unit costs are based on Means Construction Cost Data, 1982. System cost are as follows:

Item	Installed Unit Cost	Total Cost
250 Feet of 2-inch, schedule 40 galvanized steel pipe	$10.80/foot	$8.100 ($2,700 x 3)
6-Sewage ejector pumps, cast iron 110 gallon per minute, 1/2 horsepower	$1,200/each	$7,200
1-5000 Gallon steel storage	$3,850/each	$3,850
	Total =	$19,150

The total installed cost of $19,150 is equivalent to $19,700 in 1985 dollars based on Engineering News Record indices for chemical engineering plant costs. A rounded, capital cost of $20,000 per plant is conservatively estimated for segregating and collecting formulator/packager wastestreams at low flow plants. The annualized cost is $4,360 if a 0.218 factor is used for 10 year period at a 13 percent interest rate.

Several plants exhibit flows less than 2,500 gallons per year (10 gallons per day). Manual collection methods would be more appropriate at these plants. For these very low flow plants the following assumptions can be made: One 55 gallon drum could be manually filled at a cost of $14 per drum for labor; and a storage shelter (3'x9'x8'), for the drums, would cost approximately $2,000 based on Means Construction cost Data, 1982. The annualized cost is $436, if a factor of 0.218 is used.

In response to the June 13, 1984, Federal Register notice, commenters reported a range of contract hauling costs. The Chemical Specialities Manufacturers Associated (CSMA) reports a $2 to $3 per gallon cost for the contract hauling of hazardous liquid waste. The Small Business Administration reports a $2 per gallon incineration cost. Several plants estimated that the contract hauling could approach $3 to $4 per gallon. However, plants that currently incinerate pesticide-bearing wastewater state that their operating and investment costs are less than $1 per gallon. A $2.50 per gallon contract hauling cost which includes incineration in a RCRA approved incinerator is judged to be a reasonable estimate of an industry-wide cost for the year 1985. Plant-by-plant capital and annual costs are listed in Table VIII-5.

2. The four high flow plants have either demonstrated or said they would use the reduction and reuse technologies utilized for this regulation. A large percentage of the discharged wastewater can be treated to acceptable levels for reuse. Treatment technologies have been evaluated and costed by EPA in the proposed Development Document. Table VIII-8 and VIII-9 of that document list unit operations associated with the proposed manufacturer's Subcategory Two, Level One treatment costs. The unit operations listed are typical of reuse treatment technologies. Included are unit processes for the disposal of treatment wastes from filtration and carbon regeneration. A range of costs is given for treating the respective 0.01 MGD and 0.1 MGD design flows. For estimates prepared here, the high cost value is assumed to apply. Use of the high value accounts for any inflation cost indexing necessary to adjust 1979 dollars to 1985 dollars. A contract hauling cost of $2.50 is applies to those internal wastestreams that plant personnel state are not suitable for reuse. The cost of segregating and collecting PFP wastestreams is $1,4000,000 which is based on information supplied by plant No. 7.

In addition to the segregation and collection system cost reported by plant No. 7, the cost of returning treated water for reuse must be considered. The following costs apply for treated water storage and return:

Unit	Installed Unit Cost	Total Cost
1500 feet, 2 inch schedule 40, galvanized steel pipe	$10.80/ft	$16,200
400 feet, 4 inch, schedule 40, galvanized steel pipe	$24/ft	$ 9,600
50,000 gallon tank (5,000		

gal = $3,850; 210,000 gal = $57,000)	estimate	$25,000
Foundation Mat (100 cubic yards)	$15/C.Y.	$ 1,500
Ground Slab (6" thick, 500 sq. ft.)	1.93/S.F.	$ 965
		$53,265

This total installed cost corresponds to a $55,000 cost in 1984 dollars. Therefore, the total capital cost of segregation, collection and return piping and storage systems is $1,455,000.

Since a typical high flow plant uses about 7,000,000 gallons per year, some cost savings will result if recycled water is used instead of city water. Based on a city water cost of $0.005 per gallon, an average savings of $35,000 is realized. Table VIII-6 is a breakdown of costs for the 4 high flow plants.

3. The cost of achieving zero discharge at the 169 formulator/packager plants may be extrapolated from the random sample of 28 plants. Since costs are available for the 12 plants which volunteered information, these are subtracted from 169 to yield 157. The subtotal annual and capital costs for the 28 plants is multiplied by the ratio 157/28, below, to yield an extrapolated cost. The cost for the 12 plants is then conservatively added to the extrapolated cost to provide total capital and annual costs.

	Annual Cost	Capital Cost
1. 28 Randomly Selected Plants	$2,456,000	$ 2,818,000
2. Extropolated Cost	13,775,365	15,800,929
3. 12 Non-randomly Selected Plants	3,187,973	6,759,000
4. Sum of Items 2 and 3	$16,963,338	$22,559,929

The Agency continued their solicitation of information by requesting additional information in the January 24, 1985 Notice of Availability. The Agency stated, at that time, that it was considering setting formulator/packager regulations equal to manufacturer's pretreatment standards. The industry did not submit sufficient data or information to support this alternative on a technological or economic basis. If manufacturers pretreatment standards were established for PFP plants, 96 percent of the 169 indirect discharge plants would find it cheaper to comply with the regulation by contract hauling followed by incineration, rather than build a separate treatment system for the PFP flow to meet the pretreatment standard. Consequently, those plants would achieve zero discharge of process wastewater pollutants. Some of remaining 4 percent of the 163 indirect dischargers with high flows would find it cheaper to recycle and reuse the treated wastewater rather than discharge because for those plants the savings in water and monitoring costs would outweigh the costs for additional pumps and piping to recirculate the treated water for reuse. The other high flow plants may find it cheaper to treat their wastewater using the technology upon which the manufacturers pretreatment standards are based and then discharge rather than recycle the treated wastewater to meet a zero discharge requirement.

NONWATER QUALITY ASPECTS

The potential contamination of gaseous, liquid, and solid wastes will be restricted to those areas directly affected by the implementation of technology recommendations contained in this report.

Air Quality

Incineration has been recommended as a means for disposing of organic liquids and nonrecoverable solvents. The incinerator design recommended in this study is a RCRA approved incinerator which provides for the scrubbing of off-gases with caustic or lime, should there be hydrogen chloride gas present, or with water in cases where nonchlorinated liquid wastes are being fed to the incinerator. Given the proper temperature and dwell time in the combustion chamber, greater than 99.9 percent removal of pesticide active ingredients can be maintained (See Section VI) so that a potential air pollution problem is not created. Incineration, if properly designed with air pollution control device, can be an affective means for disposing of organic solvent and pesticides. However, incineration is not applicable to organic pesticides wastewaters containing high levels of mercury.

Gaudy and Kincannon (1982) studied the treatment compatability of municipal waste and 24 biologically hazardous compounds to assess the effects of priority pollutants on the performance of open and closed activated sludge treatment systems. Based on the data from the three types of open reactor studies, Strier (1985) concluded that fourteen compounds are removed mostly by air stripping, four are removed mostly by sorption, and six are mostly biodegraded.

Specifically, in batch reactor studies, naphthalene was found to be highly biodegradable and listed as being highly strippable, indicating both are significant concurrent removal pathways. Toluene biodegraded rapidly but appeared to air strip even more rapidly. Hexachlorobenzene is too insoluble to indicate anything but sorption on the MLSS (mixed-liquor suspended solids) and MLVSS (mixed-liquor volatile suspended solids). Benzene biodegrades but appears to air-strip even more rapidly as was found for toluene. Phenol biodegrades readily but manifests insignificant air stripping. Pentachlorophenol manifested minimal biochemical oxidation and no air stripping. Nitrobenzene showed some evidence of biological activity of 2-chlorophenol was unclear, except for some evidence of biodegradation; however, its air stripping characteristics were minimal, if any at all.

Anthrancene may have been sorbed and/or metabolozed by the sewage sludge, but showed no air stripping tendencies. Nitrophenol showed biological activity and/or chemical activity; however, its air stripping activity is only slight. Hexachloroethane appeared essentially inert in these tests and was not tested for stripping. Fluorene seemed to show no activity in these tests, except possibly for some sorption. There was no evidence for any stripping. Methylene chloride appeared to be air stripped at rates far greater than any possible biological activity. Carbon tetrachloride and chloroform both were stripped out of the system rapidly at rates resembling that of methylene chloride with little if any evidence of biological activity. Trichloroethylene is rapidly stripped and shows some evidence for adsorption on suspended solids. Chlorobenzene was found to be rapidly stripped from the system with very little evidence for biological activity. Tetrachloroethylene is rapidly air stripped but showed no evidence for biodegradation. 4-Chloro-3-methylphenol biodegrades but does not air strip. Ethylbenzene is predominately air stripped with little evidence for biodegradation. 1,2-Dichloroethane is air stripped with essentially no evidence for biodegradation. 1,1,2-Trichloroethane gives no evidence of biodegration but is essentially completely air stripped. Therefore, air stripping of volatile organics from biological oxidation systems is a potential air pollution problem. As a result, this regulation is based on the use of steam stripping of volatile organics as a pretreatment step before biological oxidation, in order to eliminate this air pollution problem.

Air stripping of volatile organic compounds from biological treatment systems may create potential air quality problems. This regulation is based on the use of steam stripping (with recovery of the stripped organic material) prior to biological treatment. However, the Agency has not regulated five volatile organic compounds for PSES and is concerned about resulting air quality impacts. The Agency intends to gather additional data and propose additional regulations for there pollutants in calendar year 1986.

Both solar and spray evaporation were recommended as alternative methods for disposal of low volumes of wastewater for formulators/packagers. However, based on public comments the Agency is no longer recommending these methods. The practicality of using solar and spray evaporation in northern latitudes, during winter months, was questioned by several plants.

Also, the use of evaporation ponds, unless they are appropriately lined present problems of potential ground water contamination.

On-site regeneration of activated carbon has been recommended as an alternative for the removal of pesticides, phenols, nitrosamines, and chlorinated dienes. The furnace which is utilized in this system has been provided with an afterburner to control obnoxious gases and a wet scrubber for dust collection and cooling of gases.

In a study conducted by Wagner, et al. (1979) it was determined that the conditions necessary to safely incinerate granular activated carbon reactivation off-gases were within the normal operating range of a typical afterburner. Of the eight compounds selected five were not present in their original form in the furnace off-gases (two of these five were the pesticides malathion and 2,4-D). The residual levels of the other three compounds, and the hydrocarbon decomposition products from all eight compounds, were reduced by at least 98 percent in the afterburner.

Solid Waste Considerations

Many liquid and solid wastes generated in the pesticide industry have been classified as "hazardous" by regulations under the Resource Conservation and Recovery Act (RCRA) 40 CFR, Part 261, May 19, 1980. Under the RCRA regulations, disposal of wastes off-site would require preparation of a manifest to track the movement of the waste from the generator's premises to a permanent off-site treatment, storage, or disposal facility. Specific waste streams within specific processes have been designated as hazardous, as well as specific products and raw materials. The cost of compliance with existing RCRA regulations were reviewed in order to assess the potential impact of these regulations. RCRA management costs were estimated using procedures described in the "EPA Guidance Manual for Estimating RCRA Subtitle C Compliance Costs." The costs include: (1) runoff collection and treatment system, (2) closure plan, (3) off-site management, (4) administration, (5) record-keeping, (6) monitoring and testing, (7) training, (8) contingency plan, and (9) closure and post closure financial responsibilities as applicable to each type of facility. The RCRA management costs associated with these BAT and PSES regulations are estimated to be $453,000 annually for subcategory one plants. PFP plants were costed for contract hauling and incinerating hazardous wastes at $2.50 a gallon.

Metal separation systems have been recommended for the removal of copper and zinc. Adjustment of pH using sodium hydroxide in these systems will create zinc and copper hydroxide sludges. The quantities of sludge generated are estimated to be:

Cubic Yards of Sludge Generated Per Year Per MGD	
Copper	Zinc
102,000	5,540

Protection of Ground Water

Deep well injection is practiced at 17 plants in the pesticide industry. Since this method of disposal has not been recommended by this study, its potential impact on groundwater pollution will not be addressed.

Spray irrigation of process wastewaters is practiced at three plants in the industry. Since this is not a technology recommended in this study, its potential for pollution of the ground water will not be addressed.

Table VIII-1. Basis for Capital Costs Computations (August 1983 Dollars)

Item	Capital Cost
Land	$32,700 per ace
Excavation	$6.78 per cubic yard
Materials	
Reinforced Concrete	$345 per cubic yard
Machined Steel	$2.64 per pound
Epoxy Coating	$2.50 per square foot
Liner	$0.77 per square foot
Sitework, electrical, piping and instrumentation	48% of total equipment cost
Engineering	15% of construction cost
Contingency	15% of construction cost

Table VIII-2. Basis of Annual Cost Computations (August 1983 Dollars)

Item	Capital Cost
Capital Recovery	10 years at 13% (0.218)
Taxes and Insurance	2% of capital cost
Manpower	
Labor	$24,500 per worker per year including fringe benefits
Supervision	$35,600 per worker per year including fringe benefits
Maintenance Materials	4% of capital costs
Sludge Disposal	$25 per cubic yard (non hazardous) $200 per cubic yard (hazardous)
Water	$0.60 per thousand gallons
Activated Carbon	$0.77 per pound delivered
Chemical Consumed	
Caustic Soda (50%)	$0.08 per dry pound delivered
Chlorine	$0.18 per pound delivered
Ferric Chloride	$0.37 per pound delivered
Lime	$80 per ton delivered
Methanol	$2.08 per gallon delivered
Chemicals Recovered	
Methylene Chloride	$0.37 per pound
Pesticides	$2.50 per pound
Energy Consumed	
Electricity	$0.08 per kilowatt-hour
Gas	$6.71 per one thousand cubic feet
Steam	$11.86 per thousand pounds
Energy Recovered	
Thermal	$6.08 per million BTU
Contract Haul	$2.50 per gallon (hazardous) $0.30 per gallon (non hazardous)

Table VIII-3
Treatment Technology Cost Summary for Direct and Indirect Dischargers for Peticide Manufacturing Plants

Plant #	Discharge Status	Plant Costs $(1000) Capital	Land	Annual	Energy
1	I	14274	173	7262	788
2	I	195	34	591	3
3	D	668	16	175	1
4	D	817	14	456	224
5	D	20210	161	9109	528
6	D	540	19	378	200
7	I	1179	28	505	119
8	I	918	21	254	2
9	I	2074	28	1227	622
10	D	439	12	119	53
11	I	814	27	448	209
12	D	4297	62	3398	1131
13	D	1623	22	759	193
14	D	17620	294	10496	1027
15	D	470	14	109	5
16	D	9460	76	3824	156
17	D	263	6	70	46
18	I	3590	69	1687	274
19	D	280	7	73	14
20	D	7536	90	2752	431
21	D	462	12	223	134
22A	D	722	24	355	49
22B	I	967	35	533	10
23	I	1045	38	299	155
24	I	0	0	16	0
25	D	596	16	191	42
26	I	445	16	116	9
27	I	1007	34	283	7
28	D	257	8	133	88
29	I	264	7	61	16
30	I	274	7	79	15
31	D	148	4	55	1
32	D	259	7	77	16
33	I	656	16	632	316
34	I	6298	98	2454	97
35	D	0	0	182	0
36	I	511	21	166	0
37	I	394	10	90	72
38	I	418	18	119	1
39	I	1046	25	287	248
40	I	0	0	1	0
41	D	377	10	172	74
	TOTAL	$105,176	$1,579	$50,216	$7,377

Table VIII-4
PSES Costs for Indirect Discharge Metallo-Organic Manufacturers

	Average Flow (gallons per day)								
	5,000			500			50		
	Capital	Annual	Energy	Capital	Annual	Energy	Capital	Annual	Energ
Contract Hauling[1]									
Hazardous[2]	--	3,250,000	--	--	$325,000	--	--	$32,500	-
Nonhazardous[3]	--	390,000	--	--	39,000	--	--	3,900	-

[1] 260 operating days per year

[2] $2.50 per gallon to contract haul hazardous waste

[3] $0.30 per gallon to contract haul nonhazardous waste

Table VIII-5. Summary of Annual and Capital Costs for Formulator/Packagers

(1985 dollars)

Plant No.	Regulated PFP Wastewater Volume (gallon/year)	Contract Hauling Cost ($)	Annualized Capital Costs ($)	Water Savings ($)	Total Annual Cost	Capital Cost ($)
1*	1,240	3,100	910	0	4,010	2,000
2*	400	1,000	670	0	1,670	2,000
3*	3,600	9,000	4,360	0	99,360	20,000
4*	45	113	570	0	680	2,000
5*	840	2,100	790	0	2,890	2,000
6	2,500	6,250	1,280	0	7,530	2,000
7	1,512,000	44,360	770,000	(35,000)	779,360	2,440,000
8*	1,600	4,000	1,000	0	5,000	2,000
9*	71,510	178,775	4,360	0	183,130	20,000
10*	6,400	16,000	4,360	0	20,360	20,000
11*	12,000	30,000	4,360	0	34,360	20,000
12*	100,000	250,000	4,360	0	254,360	20,000
13*	6,000	15,000	4,360	0	19,360	20,000
14*	4,000	10,000	4,360	0	14,360	20,000
15*	30	75	570	0	650	2,000
16*	14,310	35,775	4,360	0	40,130	20,000
17*	40,000	100,000	4,360	0	140,360	20,000
18*	950	2,375	820	0	3,200	2,000
19*	27,800	69,500	4,360	0	73,860	20,000
20	172,000	430,000	4,360	0	434,360	20,000
21*	50,200	125,500	4,360	0	129,860	20,000
22*	5,000	12,500	4,360	0	16,860	20,000
23*	2,500	6,250	1,280	0	7,530	2,000
24	300	750	640	0	1,390	2,000
25	19,500	48,750	4,360	0	53,110	20,000
26	3,200	8,000	4,360	0	12,360	20,000
27	4,832,000	74,360	1,092,000	(35,000)	1,313,360	3,098,000
28	28,000	70,000	4,360	0	74,360	20,000
29*	25,800	64,500	4,360	0	68,860	20,000
30*	10,600	26,500	4,360	0	30,860	20,000
31*	188,000	470,000	4,360	0	474,360	20,000
32*	11,000	27,500	4,360	0	31,860	20,000
33*	4,000	10,000	4,360	0	14,360	20,000
34	101,000	252,500	4,360	0	256,860	20,000
35*	520	1,300	710	0	2,010	2,000
36	14,716,800	0	1,092,000	(35,000)	1,057,000	3,098,000
37*	55	138	570	0	710	2,000
38*	15,860	39,650	4,360	0	44,010	20,000
39	300	750	640	0	1,390	2,000
40		0	157,600	0	157,600	455,000
	Subtotal Cost (28 randomly selected plants)				$2,456,000	$2,818,000
	Subtotal Cost (12 not- randomly selected plants)				$3,187,000	$6,759,000

Note: Asterisk (*) indicates a randomly selected plant.

Table VIII - 6

Wastewater Recycle Costs for High Flow Formulator/Packagers

	CONTRACT HAULING		WASTESTREAM SEGREGATION (2)		TREATMENT OF SEGREGATED STREAMS (3)				
Plant	Flow (gallons/ year)	Annual Cost $	Capital Cost $	Annual Cost $	Flow (gallons/ year)	Capital Cost $	Annual Cost $	Water (4) Use Savings	Total Annual Cost
36	0	0	1,455,000	317,000	14,716,800	1,643,000	775,000	(35,000)	1,057,000
7	16,000(1)	44,360	1,455,000	317,000	1,476,000	985,000	453,000	(35,000)	779,360
27	28,000	74,360	1,455,000	317,000	4,804,000	1,643,000	775,000	(35,000)	1,131,360
40(5)	0	0	0	0	5,400,000	455,000	--	--	157,600

Notes: (1) Plant No. 7 reported a contract hauling flow of 36,000 gallons per year. However, 16,000 gallons per year is used here since it is the average contract hauling flow for the 4 high flow plants. Plant No. 7 is the only randomly selected high flow plant. Since data is available for 4 of the plants, this correction is judged reasonable.

(2) Based on costs supplied by plant No. 7

(3) Based on proposed Development Document Tables VIII - 8 and 9 (November 1982).

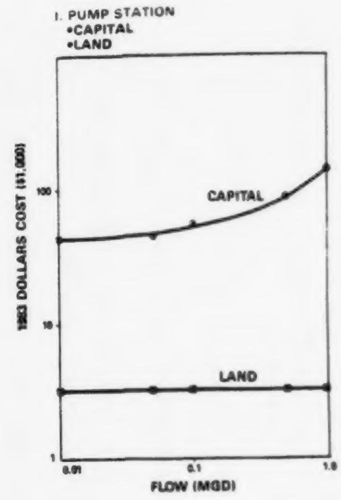
(4) Based on an average high flow plant wastestream of 7,000,000 gallons per year and a water cost of $0.005 per gallon.

(5) Based on actual plant data for an existing system.

COMPONENTS INCLUDED

WET WELL
PUMPS
50 FT. OF PIPING

CAPITAL COST



ANNUAL COST

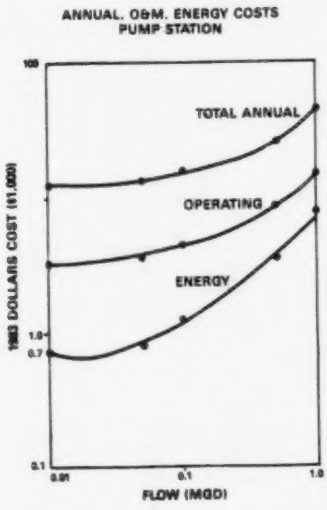
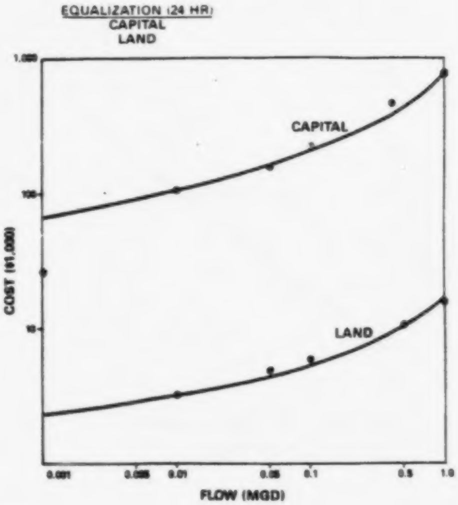


Figure VIII-1 TREATMENT COST CURVES
PUMP STATION

COMPONENTS INCLUDED

EQUALIZATION BASINS
AERATORS/MIXERS

CAPITAL COST



ANNUAL COST

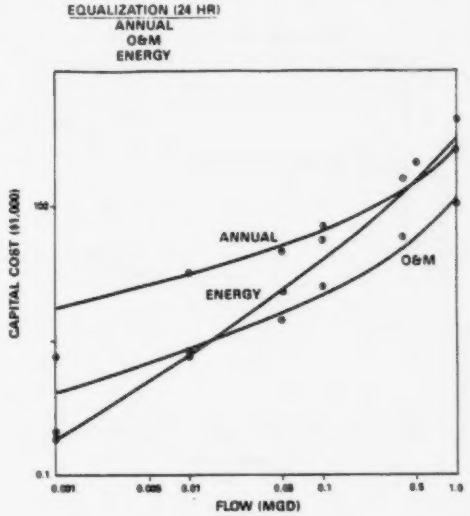
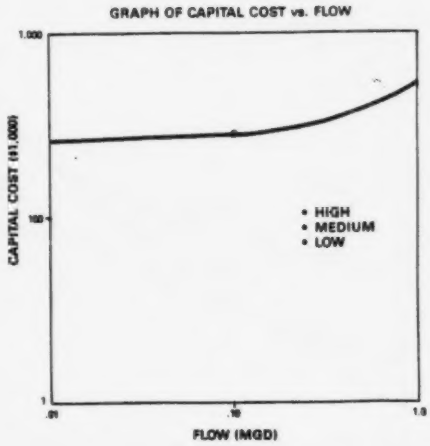


Figure VIII-2 TREATMENT COST CURVES
EQUALIZATION

COMPONENTS INCLUDED

FEED STORAGE DRUM
FEED PREHEATER
FEED PUMPS
STRIPPING COLUMN
OVERHEAD CONDENSER
SEPARATOR DRUM
HEAT EXCHANGER
EFFLUENT STORAGE DRUM

CAPITAL COST



ANNUAL COST

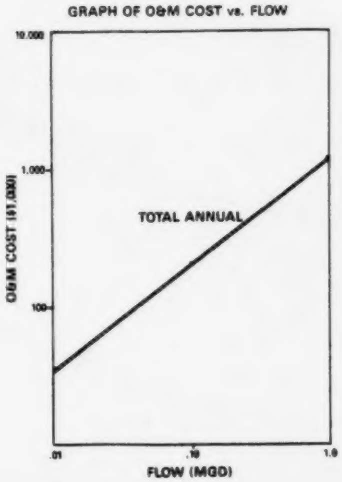
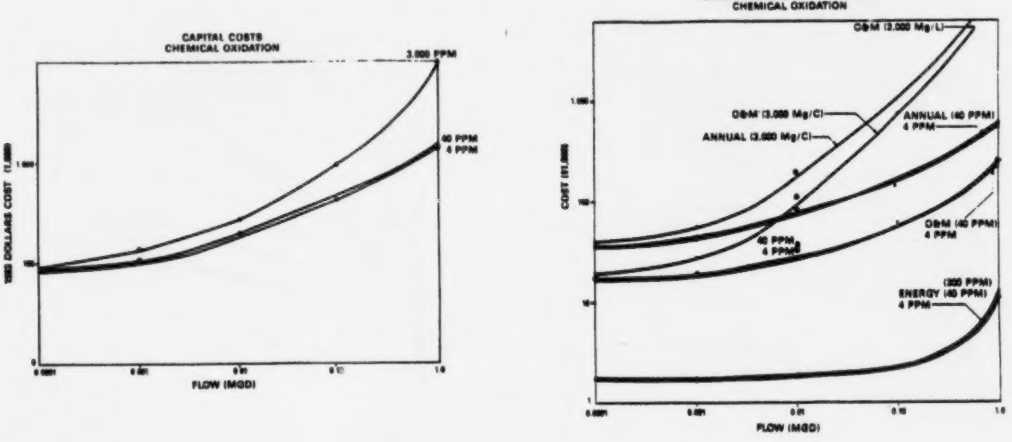


Figure VIII-3 TREATMENT COST CURVES STEAM STRIPPING

COMPONENTS INCLUDED

- FEED PUMPS
- REACTOR VESSELS
- RECIRCULATION PUMPS
- CAUSTIC STORAGE
- CHEMICAL FEEDERS
- CHLORINE STORAGE
- CHLORINATORS



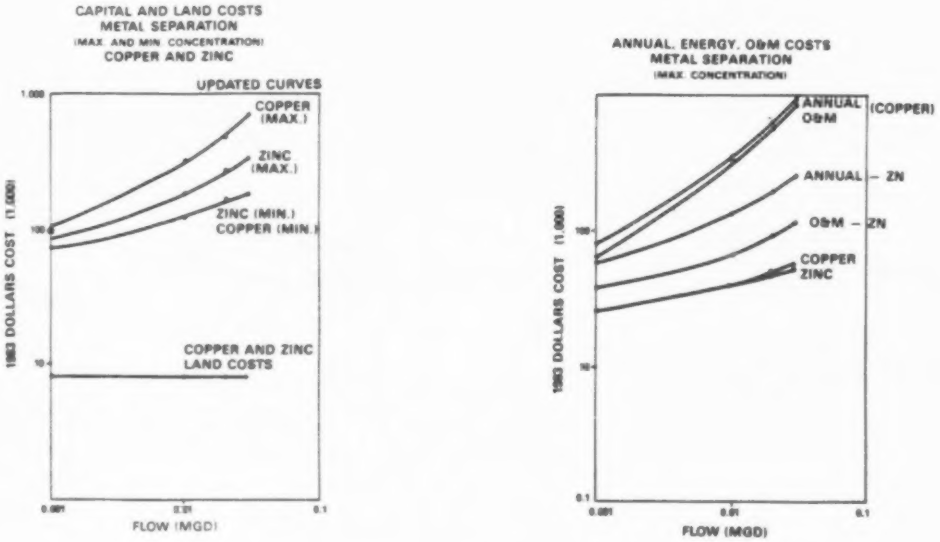
CAPITAL COST

ANNUAL COST

Figure VIII-4 TREATMENT COST CURVES
CHEMICAL OXIDATION

COMPONENTS INCLUDED

- FEED PUMPS
- MIXING TANK
- FILTER PRESS
- HOLDING TANK
- CAUSTIC STORAGE
- CHEMICAL FEEDERS
- POLYMER STORAGE
- POLYMER FEEDERS



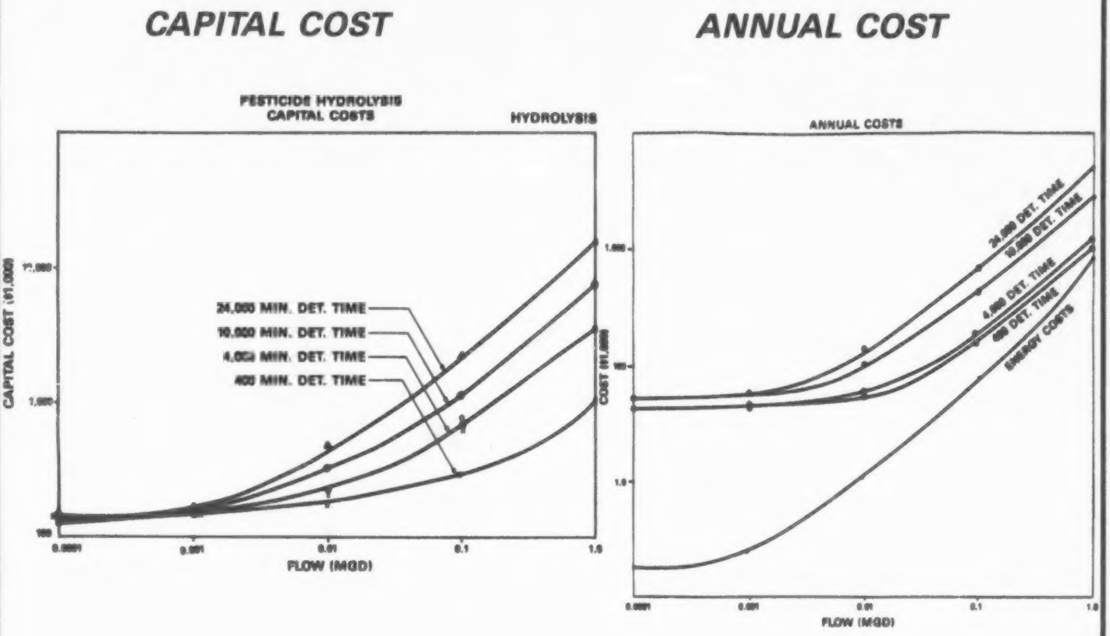
CAPITAL COST

ANNUAL COST

Figure VIII-5 TREATMENT COST CURVES METALS SEPARATION

COMPONENTS INCLUDED

- CAUSTIC STORAGE TANK
- CHEMICAL FEEDER
- MIXING TANK
- HYDROLYSIS BASINS WITH COVERS
- TEMPERATURE CONTROL
- STEAM DELIVERY AND CONTROL



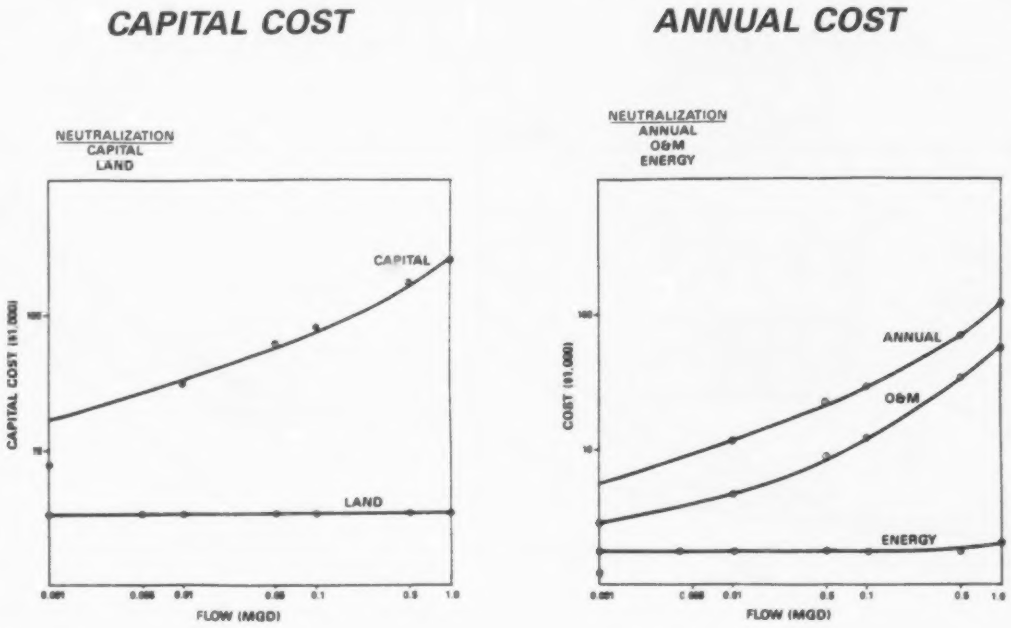
CAPITAL COST

ANNUAL COST

Figure VIII-6 TREATMENT COST CURVES
PESTICIDE HYDROLYSIS

COMPONENTS INCLUDED

CAUSTIC STORAGE TANK
CHEMICAL FEEDER
MIXING TANK



CAPITAL COST

ANNUAL COST

Figure VIII-7 TREATMENT COST CURVES
NEUTRALIZATION

COMPONENTS INCLUDED

FEED PUMPS
FILTERS
BACKWASH PUMPS

CAPITAL COST

ANNUAL COST

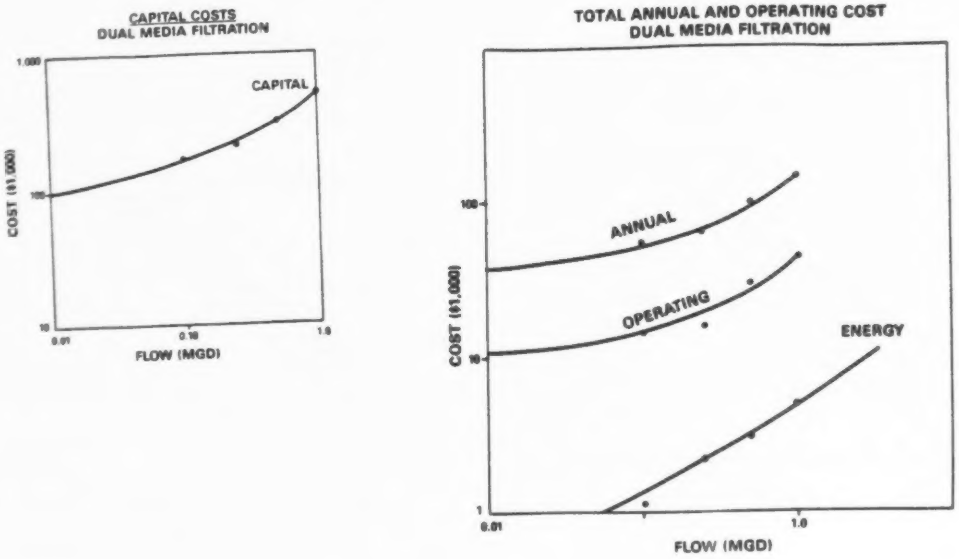


Figure VIII-8 TREATMENT COST CURVES
DUAL MEDIA PRESSURE FILTRATION

COMPONENTS INCLUDED

CARBON COLUMNS
BACKWASH PUMPS

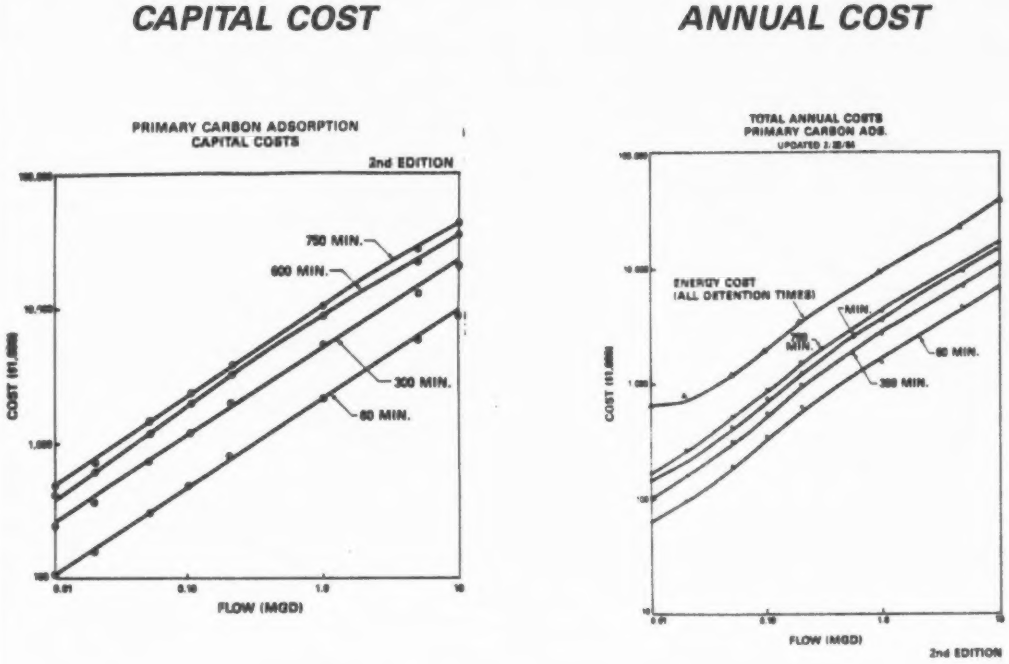
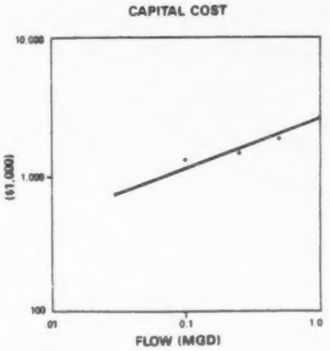


Figure VIII-9 TREATMENT COST CURVES
CARBON ADSORPTION

COMPONENTS INCLUDED

- CARBON MAKE-UP TANK
- MAKE-UP CARBON WASH TANK
- SLURRY PUMPS
- SPENT CARBON DEWATERING TANK
- FURNACE
- QUENCH TANK
- REGENERATED CARBON WASH TANK
- WASH WATER PUMPS
- AFTER BURNER
- SCRUBBER

CAPITAL COST



ANNUAL COST

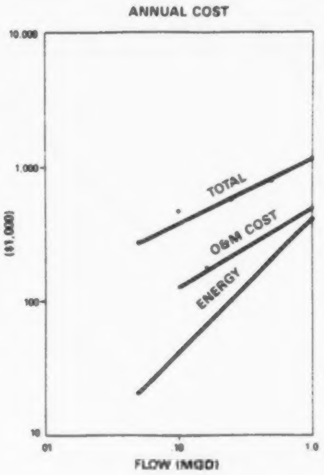
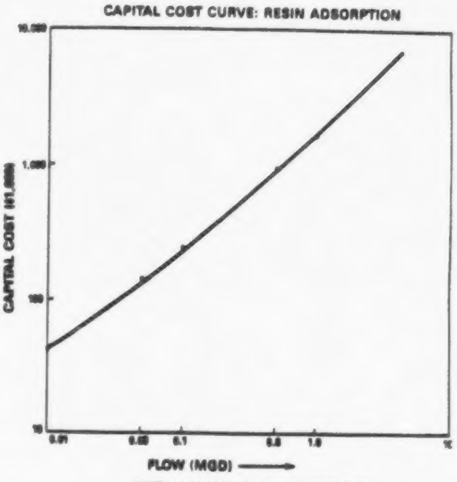


Figure VIII-10 TREATMENT COST CURVES
CARBON REGENERATION

COMPONENTS INCLUDED

RESIN COLUMNS
BACKWASH PUMPS

CAPITAL COST



NOTE: LAND COST FOR ALL CASES IS $6,500

ANNUAL COST

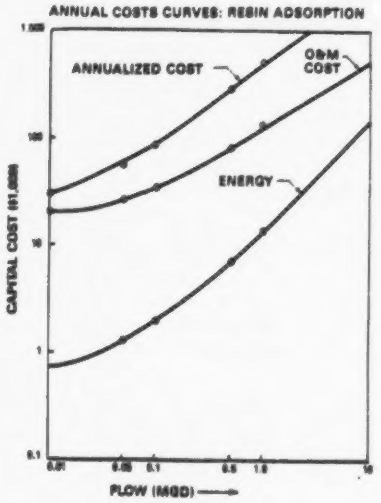
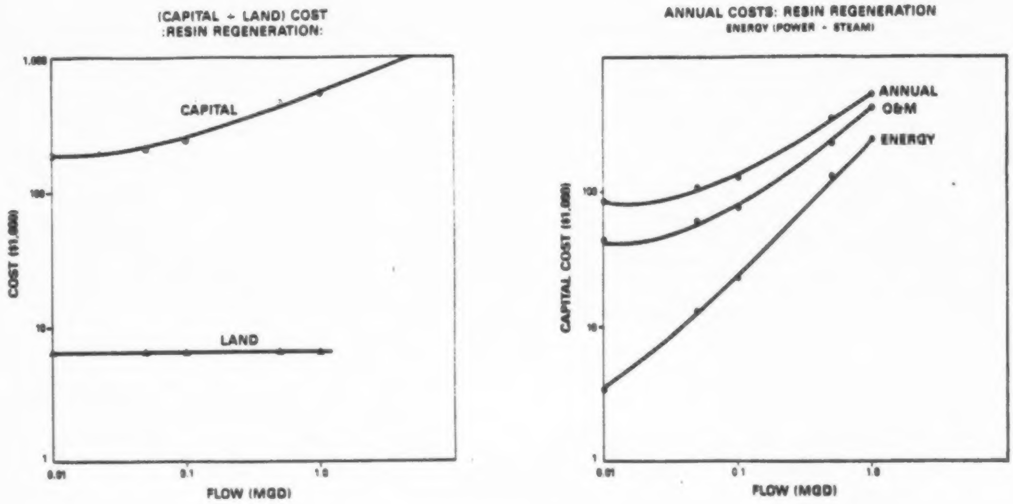


Figure VIII-11 TREATMENT COST CURVES
RESIN ADSORPTION

COMPONENTS INCLUDED

METHANOL STORAGE
PUMP
BATCH DISTILLATION COLUMN
OVERHEAD CONDENSER
REFLUX DRUM



CAPITAL COST

ANNUAL COST

Figure VIII-12 TREATMENT COST CURVES
RESIN REGENERATION

COMPONENTS INCLUDED

PHOSPHORIC ACID STORAGE
ANHYDROUS AMMONIA STORAGE
CHEMICAL FEED PUMPS

CAPITAL COST *ANNUAL COST*

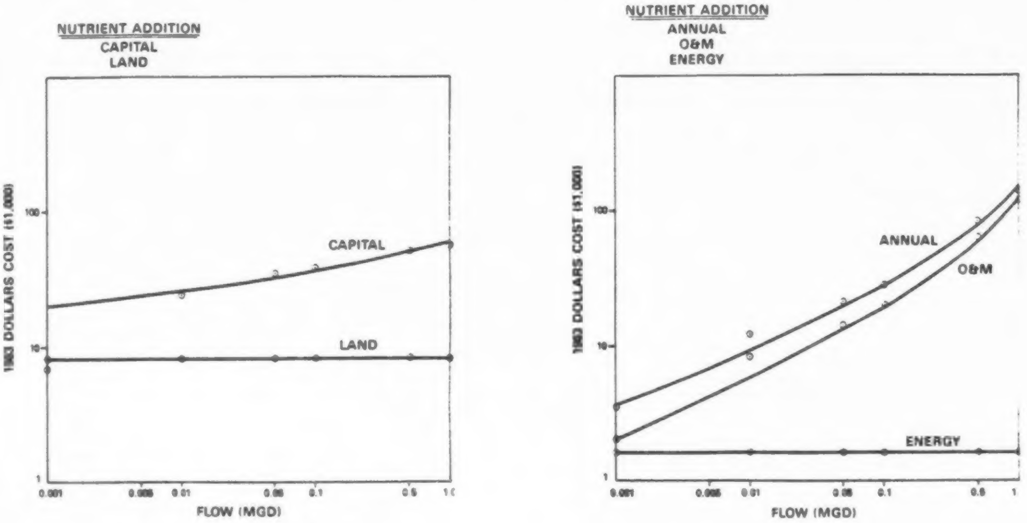
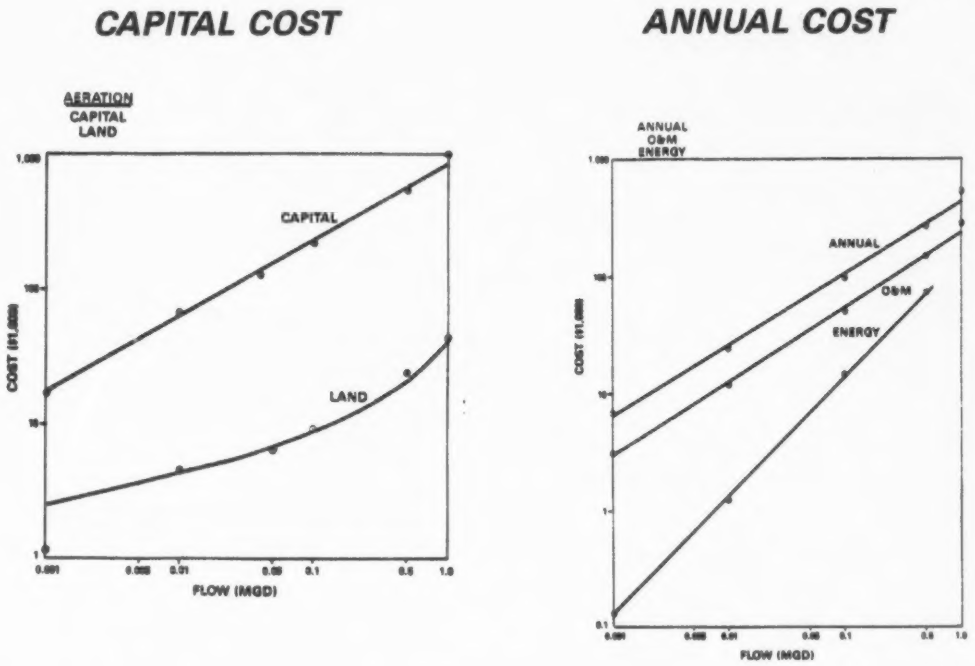


Figure VIII-13 TREATMENT COST CURVES NUTRIENT ADDITION

COMPONENTS INCLUDED

AERATION BASINS
AERATORS

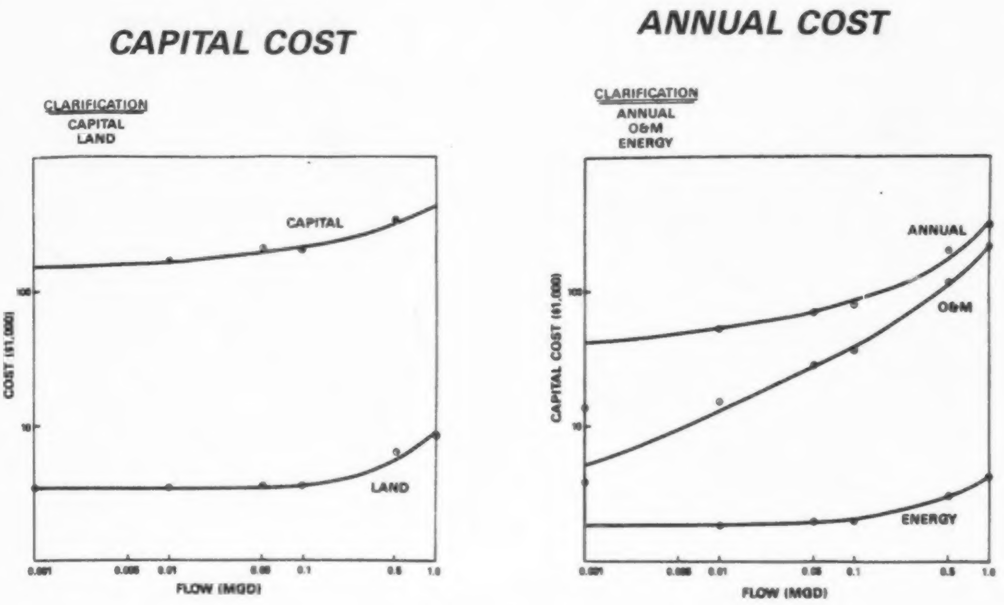

CAPITAL COST

ANNUAL COST

Figure VIII-14 TREATMENT COST CURVES
AERATION BASIN

COMPONENTS INCLUDED

CLARIFIER
SLUDGE RECYCLE PUMPS
POLYMER STORAGE AND FEEDER



CAPITAL COST

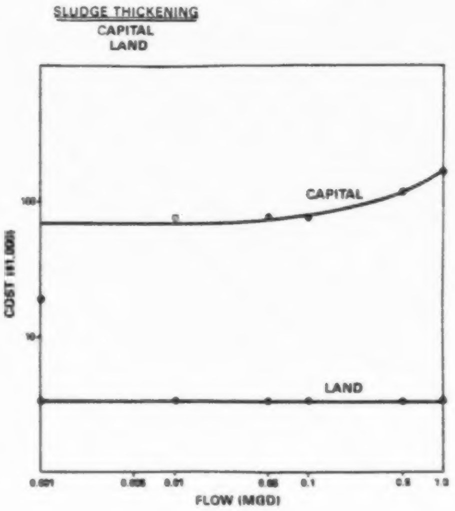
ANNUAL COST

Figure VIII-15 TREATMENT COST CURVES
CLARIFICATION

COMPONENTS INCLUDED

AIR FLOTATION TANK AND MECHANISM
SLUDGE RECYCLE PUMPS

CAPITAL COST



ANNUAL COST

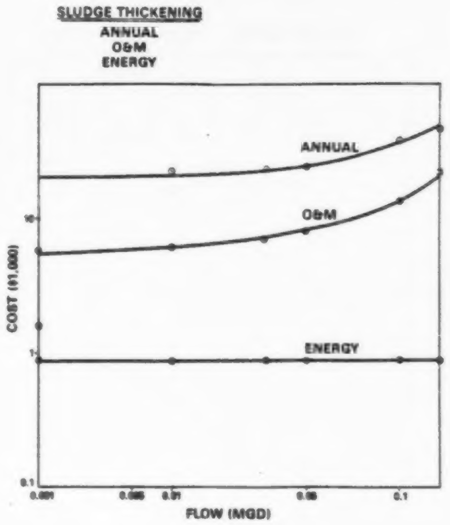
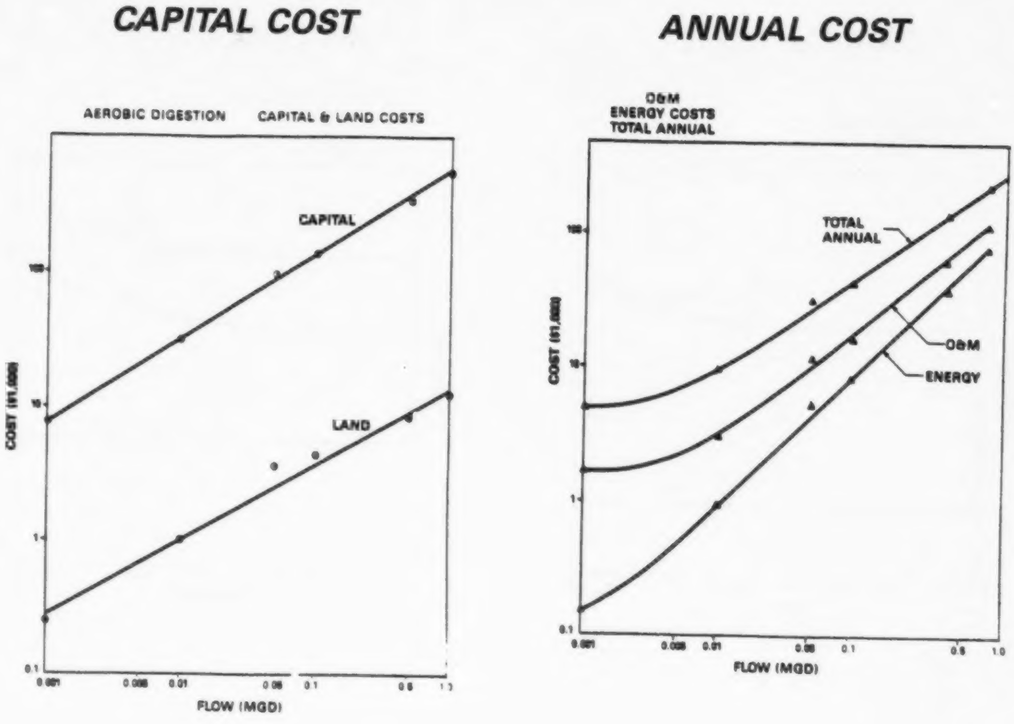


Figure VIII-16 TREATMENT COST CURVES
SLUDGE THICKENER

COMPONENTS INCLUDED

DIGESTION CHAMBER
AERATORS



CAPITAL COST

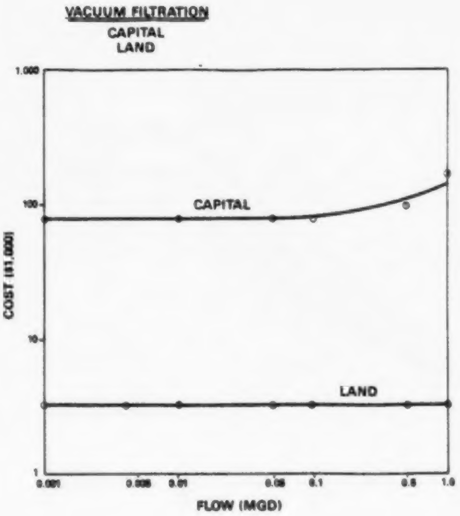
ANNUAL COST

Figure VIII-17 TREATMENT COST CURVES AEROBIC DIGESTION

COMPONENTS INCLUDED

VACUUM FILTER
CHEMICAL FEEDERS
CHEMICAL STORAGE

CAPITAL COST



ANNUAL COST

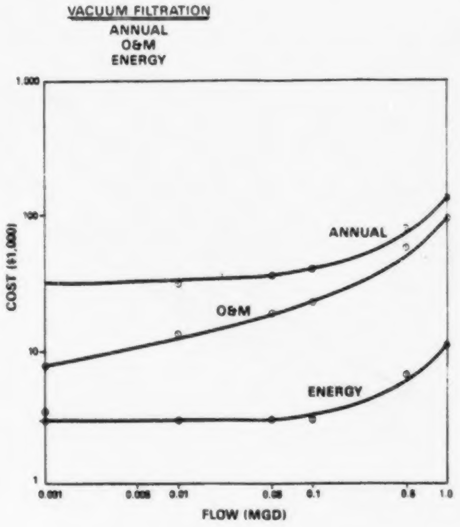


Figure VIII-18 TREATMENT COST CURVES
VACUUM FILTRATION

COMPONENTS INCLUDED

LINED PONDS

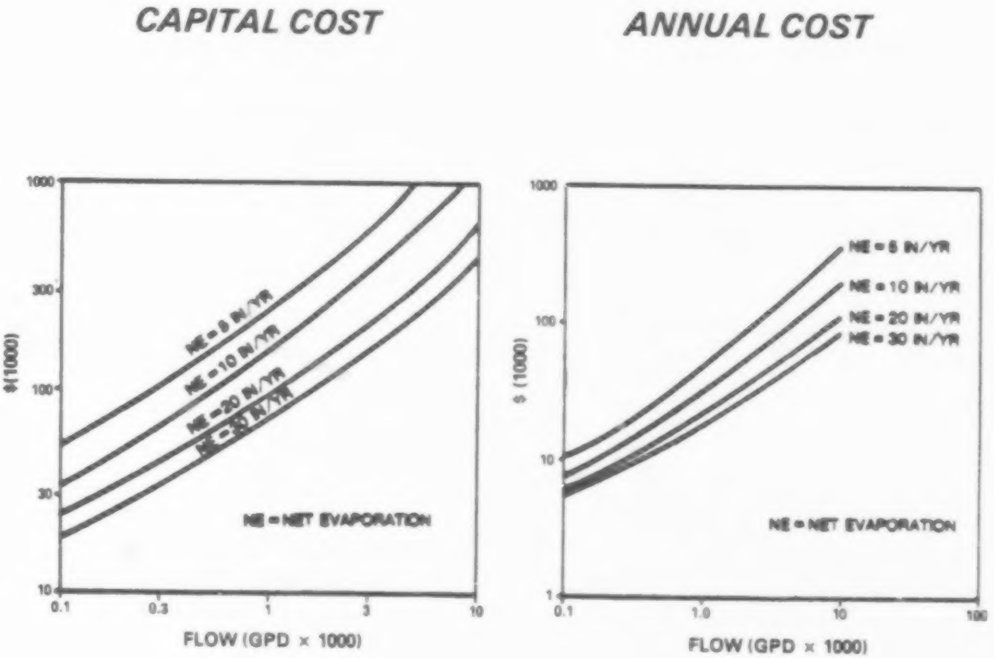


Figure VIII-19. TREATMENT COST CURVES
SOLAR EVAPORATION

SECTION IX

SELECTION OF POLLUTANT PARAMETERS RECOMMENDED TO BE REGULATED

INTRODUCTION

The purpose of this section is to define the pollutants regulated in the Pesticide Chemicals Industry and to provide the rationale for their regulation. EPA's objective was to limit the number of pollutants regulated to the minimum required to ensure proper application and operation of wastewater control technologies. The priority, nonconventional, and conventional pollutants in the scope of this study were segregated into the three groups defined below, as listed in Tables IX-1 through IX-3:

1. Pollutants of primary significance are those regulated;

2. Pollutants of dual significance are regulated only where they are the manufactured product; where they are a wastewater constituent of other pesticide products they are a pollutant of secondary significance; and

3. Pollutants of secondary significance are not currently regulated but are controlled by regulation of associated priority pollutants.

A detailed process chemistry evaluation was conducted to determine pollutants of primary and secondary significance. The nonconfidential analysis for the proposal is in volume 44 of the administrative record. The final analysis is in Section II B2 of the final promulgated record. These reports detail the decisions made, on a pollutant-by-pollutant basis, using actual plant data, process chemistry evaluations, and technology transfer.

This section summarizes these data, as well as the environmental effects and the conclusions of the process chemistry evaluations. Data to support the assumptions and conclusions are found in Section V of this report.

The rationale for assigning pollutants into these three groups was based on factors such as raw waste load level and presence, treatability, and analytical methods availability. Information used to evaluate these factors is either referenced in the bibliography and/or found in the Public Record.

Priority pollutants were initially categorized as being of primary or secondary significance, as shown in Tables IX-1 and IX-3, according to the rationale described below.

Priority pollutants detected or indicated to be present in each pesticide wastestream were examined by group as shown in Section V, as was the raw waste load level. Priority pollutants were initially classified as of primary significance if:

1. They are shown to exist independently of other priority pollutants in that group, or

2. They are shown to exist in combination with other priority pollutants in that group; but because they may be raw materials, solvents, or products, they are normally found in higher concentrations than other priority pollutants of secondary significance.

Priority pollutants were initially classified as of secondary significance because:

1. They were detected or are indicated to exist predominantly in conjunction with pollutants of primary significance, or

2. They may be impurities or reaction byproducts that are normally found in lower concentrations than priority pollutants of primary significance.

As an example of the process described above benzene, toluene, and chlorobenzene were selected as priority pollutants of primary significance in the volatile aromatic pollutant group. Ethylbenzene was considered to be of secondary significance since it predominantly exists as an impurity in benzene or toluene. Hexachlorobenzene and 1,3-dichlorobenzene were considered to be of secondary significance since they predominantly exist in conjunction with, and at lower levels than, chlorobenzene.

Once the presence and levels of priority pollutants had been initially evaluated, the relative treatability of each priority pollutant was examined. The purpose of this review was to identify any priority pollutants initially classified as of secondary significance, which because of a lesser degree of treatability could not achieve the same effluent levels as priority pollutants of primary significance in the same pollutant group. Upon completion of this review it was concluded that the pollutants of primary significance adequately represented the treatability of each group of priority pollutants and that no further additions were required.

Analytical methods availability was examined for the priority pollutants initially designated as of primary significance. It was judged that no modifications were required based on analytical methodology.

All nonconventional pesticide pollutants with promulgated analytical procedures, per 40 CFR Parts 136 and 455, were categorized as of primary significance. These pollutants are identified in Sections XIV and XV. Nonconventional pesticide pollutants which lack approved analytical procedures were categorized as of secondary significance and are not regulated at this time pending the development of analytical methods and the collection of an adequate data base. The pollutants ammonia and manganese have been detected in segments of the pesticide industry but were not prevalent in any one subcategory, therefore, they were classified as of secondary significance and national limitations and standards are not promulgated. Other nonconventional pollutants were not considered for regulation in the Pesticide Industry.

POLLUTANTS OF PRIMARY, DUAL, OR SECONDARY SIGNIFICANCE

Based upon the factors discussed above, the pollutants listed in Table IX-1 are considered of primary significance in the Pesticide Chemicals Industry. The 34 priority pollutants listed in Table IX-1 will not necessarily be found in any one pesticide plant's wastewater. The specific priority pollutants (of primary significance) recommended for regulation (monitoring) as a result of this study are listed with the associated manufactured pesticide in Section XX-Appendix 6. Whenever a plant manufactures a specific pesticide active ingredient, that discharger must meet the effluent limitations and standards for the specific priority pollutants identified in Table II-1.

The 5 priority pollutants listed in Table IX-2 are considered of dual significance in the Pesticide Chemicals Industry.

These pollutants (1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,2,4-trichlorobenzene, bis (2-chloroethyl) ether, and 1,3-dichloropropene) are classified as pollutants of primary significance if they are manufactured as a pesticide product. If these pollutants are detected or indicated to be present in other pesticide processes, they are classified as pollutants of secondary significance.

The priority pollutants listed in Table IX-3 are considered of secondary significance in the Pesticide Chemicals Industry. Priority pollutants of secondary significance which are excluded from regulation under paragraph 8 of the consent decree (NRDC v. Train) include pollutants which were previously regulated, not currently produced and unlikely to be produced in the future because their use is banned in this country, not suspected in the industry, not present in treatable amounts or are judged to be adequately controlled if the pollutants of primary significance are reduced to recommended levels. Nonconventional pesticide pollutants of secondary significance are those for which no promulgated analytical methods are available. However, some pesticides for which analytical methods do exist are not covered under regulations for manufacturers because technical data is not adequate. Reasons for the exclusion of these pesticides from the regulation for organic pesticide chemicals manufacturers is discussed in Section XIV. The Agency is, however, encouraging permit writers and control authorities to consider these and other pollutants which, on the basis of actual monitoring data or other information, may be present in a particular plants effluent. Table IX-3 identifies pollutants which are excluded from regulation. An affidavit has been filed with the Court of Appeals defining the reasons for paragraph 8 selection. See Section XX-Appendix 10.

A detailed discussion of the selection rationale for priority pollutants, nonconventional pollutants, and conventional pollutants follows.

PRIORITY POLLUTANTS

Priority pollutants recommmended as of primary, dual, or secondary significance are discussed by pollutant group in order of their approximate frequency of occurrence as follows.

Volatile Aromatics

There are nine compounds which represent the volatile aromatic priority pollutant group. Benzene, chlorobenzene, and toluene were chosen as pollutants of primary significance since they are used as raw materials and solvents and are found in higher concentrations than the other volatile aromatic compounds.

Primary Significance--In the pesticide industry, benzene is used as a raw material in the production of seven pesticides. It is used as a solvent in at least 11 pesticide processes, and it is indicated to be present in an additional 96 processes (primarily as an impurity in the solvent toluene). It has been detected in raw waste loads at concentrations up to 180,000 mg/l. While benzene in treated effluents has been observed for the most part to be less than 1 mg/l, this level may have been achieved by volatilization in biological systems, thereby creating a potential air pollution problem.

In the pesticide industry, chlorobenzene is detected or indicated to be present in 32 pesticide processes as a solvent, raw material, impurity, or final product. Of 21 processes monitored, chlorobenzene has been measured in raw waste loads at levels up to 979 mg/l.

In the pesticide industry, toluene is detected or indicated to be present in 108 pesticide processes as a solvent, raw material, or impurity. Of 35 processes monitored, toluene concentrations in raw waste loads ranged from not detected to 294,000 mg/l.

Dual Significance--In the pesticide industry, 1,2-dichlorobenzene is detected or indicated to be present in 26 pesticide processes as a final product, raw material impurity, solvent impurity, or a reaction byproduct. Raw waste concentrations of 1,2-dichlorobenzene have ranged up to 127 mg/l. 1,2-Dichlorobenzene is regulated as a priority pollutant only if it is manufactured as a product. In other processes it is adequately controlled by regulation of the priority pollutant of primary significance, chlorobenzene.

In the pesticide industry, 1,4-dichlorobenzene is detected or indicated to be present in 26 pesticide processes as a final product, raw material impurity, or as a solvent impurity. Raw waste load concentrations of 1,4-dichlorobenzene have ranged up to 85.0 mg/l. 1,4-Dichlorobenzene is regulated as a priority pollutant only if it is manufactured as a product. In other processes it is adequately controlled by regulation of the priority pollutant of primary significance, chlorobenzene.

In the pesticide industry, 1,2,4-trichlorobenzene is detected or indicated to be present in 25 pesticide processes as a reaction byproduct, raw material impurity, or a stripper impurity. Raw waste load concentrations of 1,2,4-trichlorobenzene have ranged up to 36.0 mg/l. 1,2,4-Trichlorobenzene is regulated as a priority pollutant only if it is manufactured as a product. In other processes it is adequately controlled by regulation of the priority pollutant of primary significance, chlorobenzene.

Secondary Significance--In the pesticide industry, 1,3-dichlorobenzene is detected or indicated to be present in 26 pesticide processes as a raw material impurity, solvent impurity, or a reaction byproduct. Raw waste load concentrations of 1,3-dichlorobenzene have ranged up to 127 mg/l. 1,3-Dichlorobenzene is adequately controlled by regulation of the priority pollutant of primary significance, chlorobenzene.

In the pesticide industry, ethylbenzene is detected or indicated to be present in 103 pesticide processes as a raw material, solvent impurity, or a raw material impurity. Raw waste load concentrations of ethylbenzene have ranged up to 7.9 mg/l. Ethylbenzene is be adequately controlled by regulation of the priority pollutants of primary significance, benzene and toluene.

In the pesticide industry, hexachlorobenzene is detected or indicated to be present in 16 pesticide processes as reaction byproducts, solvent impurity, or raw material impurity. Raw waste load concentrations of hexachlorobenzene have been detected at levels less than 0.008 mg/l. Hexachlorobenzene is adequately controlled by regulation of the priority pollutant of primary significance, chlorobenzene.

Halomethanes-

There are eight compounds which represent the halomethane priority pollutant group. Carbon tetrachloride, chloroform, methyl bromide, methyl chloride, and methylene chloride were chosen as pollutants of primary significance since they are used as raw materials and solvents and are found in higher concentration than the other halomethane compounds.

Primary Significance--In the pesticide industry, carbon tetrachloride is detected or indicated to be present in 46 pesticide processes as a solvent, organic stripper solvent, solvent impurity, reaction byproduct, or raw material impurity. Carbon tetrachloride concentrations in raw waste loads have been detected at levels up to 121 mg/l.

In the pesticide industry, methyl bromide (bromomethane) is detected or indicated to be present in four pesticide processes as a final product, raw material, a reaction byproduct, or an impurity. Raw waste load concentrations have been monitored up to 2,600 mg/l.

In the pesticide industry, methyl chloride is detected or indicated to be present in 49 pesticide processes as a solvent and organic stripper solvent, or as raw material, raw material impurity, or reaction byproduct. Methyl chloride has been monitored in only nine pesticide process raw wastes with concentrations measured less than 1.0 mg/l.

In the pesticide industry, methylene chloride is detected or indicated to be present in 52 pesticide processes as a solvent, impurity, or reaction byproduct. Of 17 processes monitored, methylene chloride was detected in raw waste loads at concentrations equal to or less than 31,000 mg/l.

Secondary Significance--In the pesticide industry, bromoform (tribromomethane) is detected or indicated to be present in six pesticide processes as either a reaction byproduct or as an impurity. Only trace levels were detected in the four processes monitored. Bromoform is adequately controlled by regulation of the priority pollutant of primary significance, methyl bromide.

In the pesticide industry, chlorodibromomethane is indicated to be present in two pesticide process as a reaction byproduct. Raw waste load concentrations of chlorodibromomethane are not available in the pesticide industry. Chlorodibromomethane is adequately controlled by regulation of the priority pollutants of primary significance, methylene chloride and methyl bromide.

In the pesticide industry, dichlorobromomethane is detected or indicated to be present in two pesticide processes as a reaction byproduct. Dichlorobromomethane is adequately controlled by regulation of the priority pollutants of primary significance, methylene chloride and methyl bromide.

Cyanide

Cyanide represents a priority pollutant group. Cyanide was chosen as a pollutant of primary significance since it is a unique compound in the pesticide industry where it is used as a raw material and is found in significant concentrations in pesticide raw waste loads.

Primary Significance--In the pesticide industry, cyanide is detected or indicated to be present in 42 pesticide processes as a raw material, impurity, or reaction byproduct. Of the 17 pesticide processes monitored, cyanide was present in levels ranging up to 5,503 mg/l in raw waste loads.

Haloethers--There are six compounds which represent the haloether priority pollutant group. Haloethers were not selected as pollutants of primary significance, since they were not found above detectable levels. However, bis(2-chloroethyl) ether has been classified as a pollutant of dual significance since it is manufactured as a product and has zero wastewater discharge.

Dual Significance--In the pesticide industry, bis(2-chlorethyl) ether (BCEE) is detected or indicated to be present in 12 pesticide processes as a final product, reaction byproduct, or raw material impurity. BCEE has been detected in only one process raw waste load and was found at a concentration of 0.582 mg/l. Bis(2-chloroethyl) ether is regulated as a priority pollutant only if it is manufactured as a product.

Secondary Significance--In the pesticide industry, bis(2-chloroethoxy) methane is indicated to be present in 11 pesticide processes as a reaction byproduct or an impurity. This compound has not been detected in raw waste loads monitored.

In the pesticide industry, bis(2-chloroisopropyl) ether is indicated to be present in 14 pesticide processes as a reaction byproduct or an impurity. This compound has not been detected in monitored raw waste loads.

In the pesticide industry, 4-bromophenyl phenyl ether is indicated to be present in one pesticide process as a reaction byproduct. This compound has not been detected in the waste streams monitored in the pesticide industry.

In the pesticide industry, 2-chloroethyl vinyl ether is indicated to be present in 14 pesticide processes as a reaction byproduct or as an impurity. This compound has not been detected in the pesticide industry.

In the pesticide industry, 4-chlorophenyl phenyl ether is indicated to be present in 20 pesticide processes as a reaction byproduct. This compound has not been detected in monitored waste streams.

Phenols-There are 11 compounds which represent the phenol priority pollutant group. 2,4-Dichlorophenol, 2,4-dinitrophebnol, 4-nitrophenol, pentachlorophenol, and phenol were chosen as pollutants of primary significance since they are used as raw materials or produced as final products, and are found in higher concentrations than the other phenolic compounds.

Primary Significance--In the pesticide industry, 2,4-dichlorophenol is detected or indicated to be present in 23 pesticide processes as a raw material, raw material impurity, or reaction byproduct. Of the 15 process raw waste loads monitored, the concentration of 2,4-dichlorophenol ranged from 0.042 mg/l to 42,000 mg/l.

In the pesticide industry, 2,4-dinitrophenol is detected or indicated to be present in three pesticide processes as a raw material or raw material impurity. 2,4-Dinitrophenol concentrations in raw waste loads have been detected at levels up to 7.91 mg/l.

In the pesticide industry, 4-nitrophenol is detected or indicated to be present in four pesticide processes as a raw material or reaction byproduct. Of the three process raw waste loads monitored, 4-nitrophenol has been detected in raw waste streams with concentrations ranging from 0.002 mg/l to 461 mg/l.

In the pesticide industry, pentachlorophenol is detected or indicated to be present in seven pesticide processes as a final product or reaction byproduct. Of two processes monitored, pentachlorophenol concentrations in raw waste loads ranged from 1.0 mg/l to greater than 1,000 mg/l.

In the pesticide industry, phenol is detected or indicated to be present in 26 pesticide processes as a raw material, impurity, or reaction byproduct. There have been ten processes monitored for phenol with concentrations ranging from 0.27 mg/l to 1,100 mg/l.

Secondary Significance--In the pesticide industry, 2-chlorophenol is detected or indicated to be present in 18 pesticide processes as a reaction byproduct or an impurity. Raw waste load concentrations of 2-chlorophenol have been detected at levels up to 1,000 mg/l and at 30.5 mg/l. 2-Chlorophenol is adequately controlled by regulation of the priority pollutant of primary significance, 2,4-dichlorophenol.

In the pesticide industry, 2,4-dimethylphenol is indicated to be present in three pesticide processes as a reaction byproduct or an impurity. This compound has not been detected in the waste stream monitored in the pesticide industry. 2,4-Dimethylphenol is adequately controlled by regulation of the priority pollutants of primary significance, 2,4-dichlorophenol and phenol.

The compound 4,6-dinitro-o-cresol is not indicated to be present in the pesticide industry. The presence of 4,6-dinitro-o-cresol, if any, would be adequately controlled by regulation of the priority pollutants of primary significance, 2,4-dichlorophenol and phenol.

In the pesticide industry, 2-nitrophenol is indicated to be present in two pesticide processes as an impurity. This compound has not been detected in the waste streams monitored in the pesticide industry. 2-Nitrophenol is adequately controlled by regulation of the priority pollutant of primary significance, 4-nitrophenol.

In the pesticide industry, parachlorometacresol (4-chloro-m-cresol) is indicated to be present in three pesticide processes as a reaction byproduct or an impurity. This compound has not been detected in the waste streams monitored the pesticide industry. The presence of 4-chloro-m-cresol is adequately controlled by regulation of the priority pollutants of primary significance, 2,4-dichlorophenol and phenol.

In the pesticide industry, 2,4,6-trichlorophenol is detected or indicated to be present in 18 pesticide processes as a reaction byproduct or as an impurity. Of the nine processes monitored, 2,4,6-trichlorophenol concentrations in raw waste loads ranged from 0.022 mg/l to 8,700 mg/l. 2,4,6-Trichlorophenol is adequately controlled by the regulation of the priority pollutant of primary significance, 2,4-dichlorophenol.

Nitrosubstituted Aromatics-There are three compounds which represent the nitrosubstituted aromatic priority pollutant group. There are no pollutants of primary significance in this group since 2,4-dinitrotoluene, 2,6-dinitrotoluene, and nitrobenzene are adequately controlled by the regulation of a pollutant of primary significance.

Secondary Significance--In the pesticide industry, 2,4-dinitrotoluene is indicated to be present in five pesticide processes as a reaction byproduct. This compound has not been detected in the waste streams monitored in the pesticide industry. The presence of 2,4-dinitrotoluene is adequately controlled by regulation of the priority pollutant of primary significance, toluene.

In the pesticide industry, 2,6-dinitrotoluene is indicated to be present in five pesticide processes as a reaction byproduct. The nitrosubstituted aromatic 2,6-dinitrotoluene is predominantly used as a mixture with 2,4-dinitrotoluene. This compound has not been detected in the waste streams monitored in the pesticide industry. The presence of 2,6-dinitrotoluene is expected to be adequately controlled by regulation of the priority pollutant of primary significance, toluene.

In the pesticide industry, nitrobenzene is detected or indicated to be present in 42 pesticide processes as a reaction byproduct or an impurity. Raw waste load concentrations of this compound have been detected in monitored waste streams at less than 0.01 mg/l. The presence of nitrobenzene is adequately controlled by regulation of the priority pollutant of primary significance, benzene.

Polynuclear Aromatic Hydrocarbons-There are 17 compounds which represent the polynuclear aromatic hydrocarbon (PAH) priority pollutant group. The PAHs are not detected or indicated to be present in the pesticide industry.

Secondary Significance--In the pesticide industry, acenaphthylene is indicated to be present in six pesticide processes as an impurity. Raw waste load concentrations of this compound have not been detected in monitored waste streams.

In the pesticide industry, acenaphthene is indicated to be present in six pesticide processes as an impurity. Raw waste load concentrations of this compound have not been detected in monitored waste streams.

In the pesticide industry, anthracene is indicated to be present in six pesticide processes as an impurity. Raw waste load concentrations of this compound have not been detected in monitored waste streams.

Benzo(a)anthracene is not detected or indicated to be present in the pesticide industry.

Benzo(a)pyrene is not detected or indicated to be present in the pesticide industry.

3,4-Benzofluoranthene is not detected or indicated to be present in the pesticide industry.

Benzo(ghi)perylene is not detected or indicated to be present in the pesticide industry.

In the pesticide industry, 2-chloronaphthalene is detected or indicated to be present in 18 pesticide processes as a reaction byproduct or an impurity. Raw waste concentrations of 2-chloronaphthalene have been reported at less than 0.01 mg/l.

Chrysene is not detected or indicated to be present in the pesticide industry.

Dibenzo(a,h)anthracene is not detected or indicated to be present in the pesticide industry.

In the pesticide industry, fluoranthene is indicated to be present in six pesticide processes as an impurity. Raw waste concentrations of this compound have not been detected in monitored waste streams.

Indeno(1,2,3-cd)pyrene is not detected or indicated to be present in the pesticide industry.

In the pesticide industry, naphthalene is detected or indicated to be present in 25 pesticide processes as a reaction byproduct or as an impurity. Napthalene is also associated with manufacture of biphenyl and 1,8-napthalic anhydride; these pesticides are unregulated at this time pending development of data and an analytical test method for the pesticides. Manufacture of biphenyl was discontinued in 1978. Since no limitation for napthalene was proposed and the number of manufacturers is now small this priority pollutant is not regulated.

In the pesticide industry, phenanthrene is indicated to be present in six pesticide processes as an impurity. This compound has not been detected in monitored waste streams.

Pyrene is not detected or indicated to be present in the pesticide industry.

Metals-There are 13 compounds which represent the metals priority pollutant group. Copper, mercury and zinc were chosen as pollutants of primary significance since they are detected or indicated to exist in significant concentrations and are independent of other priority pollutants in this group.

Primary Significance--In the pesticide industry, copper is detected or indicated to be present in 11 pesticide processes as a raw material or catalyst. Of six pesticide process raw waste loads monitored, copper was present at levels ranging from not detected to 59,000 mg/l.

Mercury is detected to be present in one pesticide manufacturing processes as a raw material. Raw waste load concentration of 32,000 mg/l have been measured.

In the pesticide industry, zinc is detected or indicated to be present in 11 pesticide processes as a raw material, catalyst, or as an impurity. Of two processes monitored, zinc concentrations were detected in raw waste streams at a level of 247 mg/l. Secondary Significance--Antimony is not detected or indicated to be present in the pesticide industry in concentrations over the treatability level of 0.1 mg/l. In the pesticide industry, arsenic is detected or indicated to be present in several pesticide processes as a raw material impurity. Arsenic has been detected in significant concentrations in treated effluent.

Beryllium is not detected or indicated to be present in the pesticide industry in concentrations over the treatability level of 0.05 mg/l.

Cadmium is not detected or indicated to be present in the pesticide industry over treatability levels of 0.1 g/l.

Chromium is not detected or indicated to be present in the pesticide industry in concentrations above the treatability level of 0.1 mg/l.

Lead is not detected or indicated to be present in the pesticide industry in concentrations over the treatability level of 0.1 mg/l.

In the pesticide industry, nickel is indicated to be present in one pesticide process as a catalyst. Nickel is not indicated to be present in concentrations over the treatability level of 0.1 mg/l.

Selenium is not detected or indicated to be present in the pesticide industry in concentrations over the treatability level of 0.1 mg/l.

Silver is not detected or indicated to be present in the pesticide industry in concentrations over the treatability level of 0.1 mg/l.

Thallium is not detected or indicated to be present in the pesticide industry in concentrations over the treatability level of 0.1 mg/l.

Chlorinated Ethanes and Ethylenes-There are 12 compounds which represent the chlorinated ethanes and ethylenes priority pollutant group.

Primary Significance--1,2-Dichloroethane and tetrachloroethylene were chosen as pollutants of primary significance since they are used as solvents in the industry and are found in higher concentrations than the other compounds in this group. In the pesticide industry, 1,2-dichloroethane is detected or indicated to be present in 30 pesticide processes as a solvent, reaction byproduct, or as an impurity. Of the six process raw waste loads monitored, 1,2-dichloroethane concentrations were detected up to 10,000 mg/l. In the pesticide industry, tetrachloroethylene is detected or indicated to be present in 17 pesticide processes as an impurity, reaction byproduct, or solvent. Of the four processes monitored, tetrachloroethylene concentrations in raw waste loads ranged from 0.37 mg/l to less than 98.0 mg/l.

Secondary Significance--In the pesticide industry, chloroethane is indicated to be present in 30 pesticide processes as a reaction byproduct or as an impurity. This compound was not detected in monitored waste streams. The presence of chloroethane is adequately controlled by regulation of the priority pollutant of primary significance, 1,2-dichloroethane.

In the pesticide industry, 1,1-dichloroethane is indicated to be present in 30 pesticide processes as a reaction byproduct or an impurity. This compound has not been detected in monitored waste streams. 1,1-Dichloroethane is adequately controlled by the regulation of the priority pollutant of primary significance, 1,2-dichloroethane.

In the pesticide industry, 1,1-dichloroethylene is indicated to be present in 19 pesticide processes as a reaction byproduct or an impurity. This compound has not been detected in monitored waste streams. The priority pollutant 1,1-dichloroethylene is adequately controlled by regulation of the priority pollutant of primary significance, 1,2-dichloroethane.

In the pesticide industry, hexachloroethane is indicated to be present in 11 pesticide processes as a reaction byproduct or an impurity. This compound has not been detected in monitored waste streams. Hexachloroethane is adequately controlled by regulation of the priority pollutant of primary significance, 1,2-dichloroethane.

In the pesticide industry, 1,1,2,2-tetrachloroethane is detected or indicated to be present in 30 pesticide processes as a reaction byproduct or an impurity. Raw waste concentrations of this compound have been detected at 1.70 mg/l in monitored waste streams. This compound is adequately controlled by regulation of the priority pollutant of primary significance, 1,2-dichloroethane.

In the pesticide industry, 1,2-trans-dichloroethylene is indicated to be present in 19 pesticide processes as a raw material or an impurity. This compound has not been detected in monitored waste streams. This compound is expected to be adequately controlled by regulation of the priority pollutant of primary significance, tetrachloroethylene.

In the pesticide industry, 1,1,1-trichloroethane is indicated to be present in 30 pesticide processes as a reaction byproduct. This compound has not been detected in monitored waste streams. The presence of 1,1,1-trichloroethane is adequately controlled by regulation of the priority pollutant of primary significance, 1,2-dichloroethane.

In the pesticide industry, 1,1,2-trichloroethane is detected or indicated to be present in 30 pesticide processes as a reaction byproduct or an impurity. This compound has been detected in concentrations up to 0.02 mg/l in monitored waste streams. 1,1,2-Trichloroethane is adequately controlled by regulation of the priority pollutant of primary significance, 1,2-dichloroethane.

In the pesticide industry, trichloroethylene is detected or indicated to be present in 19 pesticide processes as a reaction byproduct or an impurity. Raw waste concentrations have ranged up to 0.052 mg/l in monitored raw wastewater streams. The presence of trichloroethylene is adequately controlled by regulation of the priority pollutant of primary significance, tetrachloroethylene.

In the pesticide industry, vinyl chloride is indicated to be present in 18 pesticide processes as a raw material, reaction byproduct, or as an impurity. This compound has not been detected in monitored waste streams. Vinyl chloride is adequately controlled by regulation of the priority pollutant of primary significance, tetrachloroethylene.

Nitrosamines-There are three compounds which represent the nitrosamine priority pollutant group. N-nitrosodi-n-propylamine was chosen as a pollutant of primary significance since it is found in higher concentrations than the other priority pollutant nitrosamines and controlling it will adequately control N-nitrosodimethylamine and N-nitrosodiphenylamine.

Primary Significance--In the pesticide industry, N-nitrosodi-n-propylamine is detected or indicated to be present as a reaction byproduct in ten processes. One process has been monitored showing a maximum raw waste concentration of 1.85 mg/l.

Secondary Significance--In the pesticide industry, N-nitrosodimethylamine is detected or indicated to be present in ten pesticide processes as a reaction byproduct. Raw waste load concentrations of this compound have been monitored at less than 0.00005 mg/l. N-nitrosodimethylamine is adequately controlled by regulation of the priority pollutant of primary significance, N-nitrosodi-n-propylamine.

In the pesticide industry, N-nitrosodiphenylamine is indicated to be present in two pesticide processes as a reaction byproduct. This compound has not been detected in the waste streams monitored in the pesticide indudstry. The presence of N-nitrosodiphenylamine is adequately controlled by regulation of the priority pollutant of primary significance, N-nitrosodi-n-propylamine.

Phthalate Esters-There are six compounds which represent the phthalate ester priority pollutant group. Two phthalate esters are not detected or indicated to be present in the pesticide industry.

Secondary Significance--Bis(2-ethylhexyl) phthalate is not expected to be present in the pesticide industry.

In the pesticide industry, butyl benzyl phthalate is indicated to be present in 15 pesticide processes as a reaction byproduct or as an impurity. This compound has not been detected in the waste streams monitored in the pesticide industry.

In the pesticide industry, dimethyl phthalate is indicated to be present in 12 pesticide processes as a raw material, reaction byproduct, or as an impurity. Dimethyl phthalate is considered insignificant since it was detected in the effluent from only a small number of sources and is uniquely related to those sources.

In the pesticide industry, diethyl phthalate is indicated to be present in 15 pesticide processes as a reaction byproduct or an impurity. This compound has only been detected in trace amounts in the pesticide industry.

In the pesticide industry, di-n-butyl phthalate is indicated to be present in 15 pesticide processes as a reaction byproduct or an impurity. This compound has only been detected in trace amounts in the pesticide industry.

Dichloropropane and Dichloropropene-There are two compounds which represent the dichloropropane and dichloropropene priority pollutant group. Dichloropropane and dichloropropene were not selected as pollutants of primary significance., however, 1,3-dichloropropene has been classified as a pollutant of dual significance since it is manufactured as a final product and has zero wastewater discharge.

Dual Significance--In the pesticide industry, 1,3-dichloropropene is indicated to be present in 17 pesticide processes as a raw material, solvent, reaction byproduct, or impurity. This compound has not been detected in either of the two pesticide raw waste loads monitored. 1,3-Dichloropropene is regulated as a priority pollutant only if it is manufactured as a final product. The geometric isomers, cis-1,3-dichloropropene and trans-1,3-dichloropropene, are regulated in formulator/packager wastesteams as pesticides but are not regulated in manufacturing wastestreams.

Secondary Significance--In the pesticide industry, 1,2-dichloropropane is indicated to be present in 18 pesticide processes as a raw material, solvent, reaction byproduct, or impurity. 1,2-Dichloropropane was not detected in either of the two raw waste loads monitored.

Priority Pollutant Pesticides-There are 18 compounds which represent the priority pollutant pesticide group. BHC-alpha, BHC-beta, BHC-delta, endosulfan-alpha, endosulfan-beta, endrin, heptachlor, lindane (BHC-gamma), and toxaphene were chosen as pollutants of primary significance since they are produced as final products.

Primary Significance--In the pesticide industry, BHC-alpha is indicated to be present in 3 pesticide processes as a final product or a reaction byproduct. This compound has not been detected in waste streams monitored in the pesticide industry. BHC was previously regulated under BPT (direct discharge) only.

In the pesticide industry, BHC-beta is indicated to be present in five pesticide processes as a final product or a reaction byproduct. This compound has not been detected in waste streams monitored in the pesticide industry. BHC was previously regulated under BPT (direct discharge) only.

In the pesticide industry, BHC-delta is indicated to be present in five pesticide processes as a final product or a reaction byproduct. This compound has not been detected in the waste streams monitored in the pesticide industry. BHC was previously regulated under BPT (direct discharge) only.

In the pesticide industry, endosulfan-alpha is indicated to be present in one pesticide process as a final product. This compound has not been detected in the waste streams monitored in the pesticide industry. Endosulfan was previously regulated under BPT (direct discharge) only.

In the pesticide industry, endosulfan-beta is indicated to be present in one pesticide process as a final product. This compound has not been detected in the waste streams monitored in the pesticide industry. Endosulfan was previously regulated under BPT (direct discharge) only.

In the pesticide industry, endrin is used as a final product in one pesticide process. It has been monitored in the raw waste load at a level which is declared proprietary. Endrin was previously regulated by effluent standards and prohibitions at 40 CFR 129.

In the pesticide industry, heptachlor is detected or indicated to be present in two pesticide processes as a final product or reaction by-product. Raw waste concentrations of heptachlor have ranged up to a declared proprietary level. Heptachlor was previously regulated under BPT (dirct discharge) only.

In the pesticide industry, lindane (BHC-gamma) is indicated to be present in two pesticide processes as a final product or a reaction byproduct. This compound has not been detected in the waste streams monitored in the pesticide industry. Lindane was previously regulated under BPT (direct discharge) only.

In the pesticide industry, toxaphene is used as a final product in one pesticide process. Toxaphene concentrations in raw waste loads have been detected at levels which are declared proprietary. Toxaphene was previously regulated by effluent limitations and prohibitions at 40 CFR 129.

Secondary Significance--Priority pollutant pesticides of secondary significance are generally not covered by regulations for the manufacturing subcategory 1 but are covered by regulations for the formulator/packager subcategory 3.

In the pesticide industry, aldrin is detected or indicated to be present in one pesticide process as a reaction byproduct. Raw waste concentrations of aldrin have been monitored at a level which is declared proprietary. Aldrin is expected to be adequately controlled by regulation of the priority pollutant endrin since it is a reaction byproduct of endrin. Additionally, the pesticide aldrin was previously regulated by the effluent limitations and prohibitions at 40 CFR 129.

In the pesticide industry, chlordane is predicted to be present in two pesticide processes as a final product or a reaction byproduct. Chlordane was previously regulated under BPT (direct discharge) only.

In the pesticide industry, dieldrin is detected or indicated to be present in one pesticide process as a reaction byproduct. Raw waste concentrations of this compound have been monitored at levels which are declared proprietary. Dieldrin is adequately controlled by regulation of the priority pollutant endrin. Additionally, the pesticide dieldrin was previously regulated by the effluent limitations and prohibitions at 40 CFR 129.

In the pesticide industry, 4,4'-DDD is detected or indicated to be present in five pesticide processes as a final product or a reaction byproduct. Raw waste concentrations of 4,4'-DDD have been monitored at levels which are declared proprietary. The presence of 4,4'-DDD is adequately controlled by regulation of the pesticide methoxychlor, at the only plant where is currently manufactured. Additionally, 4,4'-DDD was previously regulated by the effluent limitations and prohibitions at 40 CFR 129.

In the pesticide industry, 4,4'-DDE is detected or indicated to be present in five pesticide processes as a final product or a reaction byproduct. Raw waste concentrations of 4,4'-DDE have been monitored at levels which are declared proprietary. The presence of this compound is adequately controlled by regulation of the pesticide methoxychlor, at the only plant where it is currently manufactured. Additionally, 4,4'-DDE was previously regulated by the effluent limitations and prohibitions at 40 CFR 129.

In the pesticide industry, 4,4'-DDT (DDT) is detected or indicated to be present in five pesticide processes as a final product, raw material, or reaction byproduct. DDT concentrations in solid wastes being contract hauled have been monitored at levels which are declared proprietary. Additionally, DDT was previously regulated by the flluent limitations and prohibitions at 40 CFR 129.

In the pesticide industry, endosulfan sulfate is indicated to be present in one pesticide process as a reaction byproduct. This compound has not been detected in waste streams monitored in the pesticide industry. Endosulfan sulfate is adequately controlled by the regulation of the priority pollutant, endosulfan.

In the pesticide industry, endrin aldehyde is indicated to be present in one pesticide process as a reaction byproduct. Raw waste concentrations of this compound have been monitored in the pesticide industry at levels which are declared proprietary. The presence of endrin aldehyde is adequately controlled by regulation of the priority pollutant, endrin.

In the pesticide industry, heptachlor epoxide is indicated to be present in two pesticide processes as a reaction byproduct. Raw waste concentrations have been monitored in waste streams at levels which are declared proprietary. Heptachlor epoxide is adequately controlled by regulation of the priority pollutant of primary significance, heptachlor.

Dienes-There are two compounds which represent the diene priority pollutant group. Hexachlorocyclopentadiene was chosen as a pollutant of primary significance since it is used as a raw material and is found in higher concentrations than hexachlorobutadiene.

Primary Significance--In the pesticide industry, hexachlorocyclopentadiene ("HEX") is detected or indicated to be present in six pesticide processes as a raw material. HEX concentrations in raw waste loads range from 0.435 mg/l to 2,500 mg/l.

Secondary Significance--In the pesticide industry, hexachlorobutadiene is detected or indicated to be present in eight pesticide processes as a solvent, reaction byproduct, or an impurity. Raw waste load concentrations have ranged up to 0.191 mg/l. Hexachlorobutadiene is adequately controlled by regulation of the priority pollutant of primary significance, hexachlorocyclopentadiene.

TCDD-2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) represents a priority pollutant group. In the pesticide industry, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) is detected or indicated to be present in 11 pesticide processes as a reaction byproduct. TCDD was chosen as a pollutant of secondary significance since significant efforts to control this compound have been undertaken in past years and the Agency is in the process of completing a study to determine the sources of remaining environmental releases, if any, or the sources of any existing contamination.

Miscellaneous Priority Pollutants-There are five compounds which represent the miscellaneous priority pollutant group. All five compounds have been chosen as pollutants of secondary significance since they lack adequate monitoring data or they are not detected or indicated to be present in this industry.

Secondary Significance--The compound acrolein is not detected or indicated to be present in the pesticide industry. The compound acrylonitrile is detected or indicated to be present in only one pesticide process.

In the pesticide industry, asbestos is detected to be present in 72 pesticide/nonpesticide wastewaters. Raw waste load concentrations have ranged from nondetectable limits to 0.3 mg/l (total calculated mass chrysotile fibers only). Asbestos is not used in this industry, and is therefore not regulated as a pollutant of primary significance. In addition, there is no promulgated method for asbestos analysis.

The compound 1,2-diphenylhydrazine is not detected or indicated to be present in the pesticide industry.

The compound isophorone is not detected or indicated to be present in the pesticide industry.

Polychlorinated Biphenyls-Seven polychlorinated biphenyls (PCBs) represent a priority pollutant group. PCBs were chosen as pollutants of secondary significance since they are not currently indicated to be present in the pesticide industry.

Secondary Significance--In the pesticide industry, PCBs are indicated to be present in one pesticide process as reaction byproducts. No data are available on the concentration of PCBs in the raw waste loads of this pesticide process. Since this pesticide is not currently manufactured, PCBs are not recommended for regulation as a pollutant of primary significance.

Benzidines-There are two compounds which represent the benzidine priority pollutant group. Benzidine and 3,3'-dichlorobenzidine were chosen as pollutants of secondary significance since they are not indicated to be present in the pesticide industry.

Secondary Significance--The compound benzidine is not indicated to be present in the pesticide industry.

The compound 3,3'-dichlorobenzidine is not indicated to be present in the pesticide industry.

All other priority pollutants not discussed above have been excluded under Sections of Paragraph 8 of the consent decree (NRDC v. Train). These pollutants are listed along with the Paragraph 8 rationale in Appendix 6.

Nonconventional Pesticide Pollutants

Nonconventional pesticide pollutants considered for regulation at this time are listed in Table 11-3 and include those for which EPA approved promulgated analytical methods are available. A general discussion of these pesticides, their properties, use in the industry and some information on production follows and provides the basis for their selection as pollutants of primary significance. The availability or absence of an EPA approved analytical method for analysis of the pesticide in wastewater effluents was the primary consideration and controlling factor which limits the main nonconventional pesticide pollutants regulated in the Pesticides Effluent Guidelines. Formulator/packager wastestreams are limited to zero discharge of priority pollutants and the pesticide active ingredients listed in Appendix D of the regulation in process wastewater generated by formulating and packaging of the pesticide active ingredients in Appendix D. The pesticide active ingredients listed in Appendix D are those for which the Agency has approved analytical methods. Manufacturing wastestreams are subject to effluent limitations for only 89 of the pesticides described here. The rationale for exclusion of the other pesticides from the organic pesticide chemicals manufacturers regulation is discussed in Section X.

Primary Significance--Alachlor is used as a pre-emergence herbicide (Martin and Worthing, 1977). Inhibition of growth in the shoots and roots of germinating seedlings is known to occur in the presence of alachlor (McEwen and Stephenson, 1979). Alachlor has a residual action lasting 10 weeks to 12 weeks (Martin and Worthing, 1977). Alachlor has a melting point of 40°C to 41°C. Its solubility in water is 240 mg/l at 23°C (Martin and Worthing, 1977). An analytizal test method is available at 40 CFR 455.

Ametryne is used as a pre- and post-emergence selective herbicide for the control of broad-leaved and grassy weeds in pineapple, sugar cane, banana, citrus, corn, and coffee crops. Ametryne forms colorless crystals with a melting point of 84 to 86°C and has a very low vapor pressure at 20°C. Its solubility in water is 185 mg/l at 20°C (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 136.

Aminocarb is a nonsystemic insecticide with acaricidal and molluscicidal activity. It is used against biting insects, mites, and slugs. Aminocarb is a white crystalline solid with a melting point of 93°C to 94°C, and is only slightly soluble in water (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 136.

(AOP) is a trade name for the diammonium salt of Nabam in a 4-percent solution (Martin and Worthing, 1977) Raw waste load concentrations of AOP have been monitored at levels which are declared proprietary. AOP is a protective fungicide which, when applied to the soil, has systemic action. An analytical test method for AOP is available at 40 CFR 455.

Atraton is a herbicide with the chemical name 2-(ethylamino), 4-(isoproylamino), 6-methoxy, s-triazine. An analytical test method is available at 40 CFR 136.

Atrazine is used as a selective pre- and post-emergence herbicide on a variety of crops including maize, sorghum, sugar cane, and pineapple. It is used in water treatment against algae and submerged plants (Martin and Worthing, 1977). Atrazine is a colorless crystal with a melting point of 175 C$^{\circ}$ to 177° C and a very low vapor pressure of 3.0 x 10-7 torr at 20° C. Its solubility in water is 28 mg/l at 20°C (Martin and Worthing, 1977). The half-life for atrazine in soil is 26 weeks to 78 weeks (Little, 1980), and it may be absorbed by clays such as montmorillonite (Little, 1980). The LD50 for fish is considered to be 12.6 mg/l (Little, 1980). It showed low toxicity in tests on rainbow trout and bluegills (Martin and Worthing, 1977). The general use and persistent nature of atrazine present the possibility for contamination of ground waters that are drinking water sources for much of the rural population of North America (McEwen and Stephenson, 1979). Traces of atrazine have been found in finished water in Iowa cities obtaining their supply from wells and in higher levels in those supplied from surface waters (McEwen and Stephenson, 1979). An analytical test method is available at 40 CFR 136.

Azinphos methyl is a nonsystemic insecticide and acaricide (Martin and Worthing, 1977). It is used against foliage-feeding insects and has broad spectrum effects (McEwen and Stephenson, 1979). Azinphos methyl is a white crystal with a melting point of 73°C to 74°C. Its solubility in water is 33 mg/l at room temperature. It is rapidly hydrolyzed by cold alkali and acid (Martin and Worthing, 1977). Persistence in the environment is long, lasting 2 or more weeks (McEwen and Stephenson, 1979). An analytical test method is available at 40 CFR 136.

Barban is a selective post-emergence herbicide used for the control of wild oats. It is a crystalline solid with a melting point of 75°C to 76°C. Its solubility in water is 11 mg/l at 25°C (Martin and Worthing, 1977). The acute oral LD50 for rats and mice is 1,300 mg/kg to 1,500 mg/kg, and the dermal LD50 for rats is 1,600 mg/kg. An analytical test method is available at 40 CFR 136.

Benfluralin acts as a pre-emergence herbicide for the control of annual grasses and broad-leaved weeds in lettuce, tobacco, and other forage crops when incorporated into the soil (Martin and Worthing, 1977). Benfluralin is a yellow-orange crystalline solid with a melting point of 65 to 66.5°C. Its solubility in water is less than 1 mg/l at 25°C. It is of low to moderate persistence in the environment (Martin and Worthing, 1977).

An analytical test method is available at 40 CFR 455.

Benomyl is a protective and eradicant fungicide with systemic activity used on a wide range of fungi in fruits, nuts, vegetables, and ornamentals. It is a white crystalline solid with a faint acrid odor. At 20°C its solubility in water is 3.8 mg/l (Martin and Worthing, 1977). Benomyl's fungicidal action is effected by adsorption to spindle fibers involved in cell division. An analytical test method is available at 40 CFR 455.

Bentazon, a contact herbicide, is used for control of Matricaria, Anthemis spp., and other plants in winter and spring cereals. It is ineffective as a pre-emergence herbicide since it is absorbed by leaves, and it has little effect on germinating seeds (Martin and Worthing, 1977). Bentazon is a white odorless crystalline powder with a melting point of 137 C to 139°C. Its solubility in water is 500 mg/L (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Bolstar is an insecticide. An analytical test method is available at 40 CFR 455.

Bromacil is recommended for general weed control on noncrop land such as railroad rights-of-way. It is a nonselective inhibitor of photosynthesis and is absorbed mainly through roots. It is also used for annual weed control in established citrus and pineapple plantations. Bromacil is a white crystalline solid with a melting point of 158°C to 159°C. Its solubility in water is 815 mg/l at 25°C (Martin and Worthing, 1977). The average half-life in the environment of bromacil is several months, and moderate mobility in the soil has been observed (McEwen and Stephenson, 1979). An analytical test method is available at 40 CFR 455.

Busan 40 is a fungicide. An analytical test method is available at 40 CFR 455. Busan 85 a fungicide. An analytical test method is available at 40 CFR 455.

Butachlor is a pre-emergence herbicide used in the control of annual grasses and certain broad-leaved weeds in rice. It is a light yellow oil with a boiling point of 196°C. Its solubility in water is 20 mg/l at 20°C (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Captan is a nonsystemic fungicide used mainly for foliage protection. The technical product is an amorphous solid, white to beige in color with a pungent odor. Its melting point is 160 °C to 170°C (Martin and Worthing, 1977). The acute oral LD50 is 9,000 mg/kg for rats. In the environment, captan decomposition produces hydrochloric acid and its rapid hydrolysis can lead to toxic effects on sensitive plants (McEwen and Stephenson, 1979). Under alkaline conditions, captan produces hydrogen sulfide gas. Captan is of relatively long persistence in the environment (Vettorazzi, 1979). An analytical test method is available at 40 CFR 136.

Carbam-S is a soil fungicide. An analytical test method is available at 40 CFR 455.

Carbaryl is a broad spectrum contact insecticide with slight systemic properties. Carbaryl is used extensively for foliar pests in agriculture, pests in home gardens and lawns, and ectoparasites (fleas and ticks) on livestock and pets (McEwen, 1979; Martin, 1977). Carbaryl is a white crystalline solid with a melting point of 142°C. Its solubility in water is 40 mg/L at 30°C (Martin and Worthing, 1977). An analytical test method is aailable at 40 CFR 136.

Carbendazim is a broad-spectrum systemic fungicide and is absorbed by the roots and the green tissue of plants. It is a light grey powder with a solubility in water of 5.8 mg/L at 20°C (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Carbofuran is a broad-spectrum, systemic insecticide, acaricide, and nematicide. It is a white, odorless, crystalline solid with a solubility in water of 700 mg/L at 25°C (Martin and Worthing, 1977). The half life of carbofuran in the soil ranges from 30 days to 80 days (McEwen and Stephenson, 1979). An analytical test method is available.

Carbophenothion is a nonsystemic insecticide and acaricide used for preharvest treatments on deciduous and citrus fruits. It is also used as seed dressing for cereal grains (Vettorazzi, 1979). It is an off-white to amber-colored liquid with a mild mercaptan-like odor. Its boiling point is 82°C and it is soluble in water at the rate of 40 mg/L (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 136.

Chlorobenzilate is a nonsystemic acaricide, of little insecticidal action, used for the control of mites on citrus and deciduous fruit. It is a pale yellow solid with a melting point of 35°C to 37°C and a boiling point of 156°C to 158°C. The technical product is a brownish liquid of approximately 96 percent purity and is practically insoluble in water (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Chlorpropham is a selective pre-emergence herbicide and mitotic poison. It has been generally used to prevent potato sprouting (Martin and Worthing, 1977). Its solubility in water at 25°C is 89 mg/L, and its melting point is from 38.5°C to 40°C. An analytical test method is available at 40 CFR 136.

Chlorpyrifos is a broad spectrum insecticide and is effective by contact, ingestion, and vapor action. It is used for the control of larvae and adult mosquitos, soils, and foliar crop pests, and for ectoparasites on sheep and cattle (Martin and Worthing, 1977; McEwen and Stephenson, 1979). Chlorpyrifos persists in the soil for 2 to 4 months (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Chlorpyrifos methyl has a broad range of activity against insects and is effective by contact, ingestion, and vapor action. Chlorpyrifos methyl is used on stored grains foliar crop pests. Its form is white crystals with a slight mercaptan odor and a melting point of 45.5°C to 46.5°C. Its solubility in water is 4 mg/L at 25°C (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Coumaphos is a contact and systemic insecticide used on animals, including poultry. Application is made by dipping, spraying, adding to feed, and dusting. An analytical test method is available at 40 CFR 455.

Cyanazine is a pre- and post-emergence herbicide used for general weed control. It is a white crystalline solid with a melting point of 166.5°C and solubility in water of 171 mg/L (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

2,4-D along with its salts and esters (2,4-D isobutyl ester and 2,4-D isocotyl ester) are systemic herbicides used for the weeding of cereals and other crops. 2,4-D is a white powder with a slight phenolic odor. 2,4-D has a melting point of 140.5

°C, and its solubility in water is 620 mg/L at 25°C (Martin and Worthing, 1977). 2,4-D persists in the soil for at least 1 month (Martin and Worthing, 1977). An analytical test method for 2,4-D and its salts and esters is available at 40 CFR 136.

2,4-DB and its esters (2,4-DB isobutyl ester and 2,4-DB isoctyl ester) are translocatable herbicides similar to 2,4-D. They are more selective because their activity depends on oxidation to 2,4-D by the plant. It is used on lucerne, undersown cereals, and grasslands. An analytical test method for 2,4-DB and its esters is available at 40 CFR 455.

DBCP (dibromochloropropane) is a soil fumigant used in the control of nematodes. It is an amber to dark brown liquid with a mildly pungent odor and a boiling point of 196°C. Its solubility in water is 1000 mg/L at room temperature (Martin and Worthing, 1977). DBCP is persistent in the soil, thereby requiring a long aeration time before planting such crops as potatoes and tobacco (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

DCNA (dichloran) is a protectant fungicide which is used for foliar application and soil treatment. During preharvest it is used on vegetables and cotton, while at post harvest it is used as a dip for peaches, nectarines, and carrots (Vetbtorazzi, 1979). It is a yellow odorless crystalline solid with a melting point of 195°C. DCNA is practically insoluble in water (Martin and Worthing, 1977). An analytical test method for dichloran is available at 40 CFR 136.

Deet is an insect repellent which is effective against mosquitoes. It is a colorless to amber liquid with a boiling point of 111°C. Deet is practically insoluble in water (Martin and Worthing, 1977). An analytical test method for deet is available at 40 CFR 455.

Demeton is a systemic insecticide and acaricide which has some fumigant action. It rapidly penetrates plants and is effective against sap-feeding insects and mites. Demeton is a colorless oil with a boiling point of 123°C. Its solubility in water is 60 mg/L at room temperature (Martin and Worthing, 1977). Analytical test methods for demeton, demeton-o, and demeton-s are available at 40 CFR 136.

Demeton-o is a systemic insecticide and acaricide which has some fumigant action. It is a colorless oil with a boiling point of 123°C. Its solubility in water is 60 mg/L at room temperature.

Demeton-s is a systemic insecticide and acaricide which has some fumigant action. It is a colorless oil with a boiling point of 128°C. Its solubility in water is 2000 mg/L at room temperature.

Diazinon is a nonsystemic insecticide and acaricide used on rice, sugar cane, corn, tobacco, and potatoes. It is a pale to dark brown liquid with a solubility in water of 40 mg/L. Diazinon persists on plants for 7 days to 10 days (McEwen and Stephenson, 1979). An analytical test method for diazimon is available at 40 CFR 136.

Dicamba is a post-emergence, translocateable herbicide used for weed control in cereals. The pure compound is a white crystalline solid with a melting point of 114 to 116°C. Its solubility in water is 4500 mg/L at 25°C. The technical acid is a pale buff crystalline solid of about 83 percent to 97 percent purity (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 136.

Dichlofenthion is a nonsystemic insecticide and nematicide which is applied to the soil. It is a colorless liquid with a boiling point of 120 to 123°C. Its solubility in water is 0.245 mg/L at 25°C. The technical product is 95 percent to 97 percent pure (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 136.

Cis-1,3-dichloropropene and trans-1,3-dichloropropene are geometric isomers of 1,3-dichloropropene which was discussed under priority pollutants. Analytical test methods for priority pollutants are available at 40 CFR 136.

Dichlorophen salt is the sodium salt form of dichlorophen. Dichlorophen is a fungicide and bactericide used in the protection of materials from molds and algae. It is also employed in combating tapeworm infestation in man and animals as well as being a component in an athlete's foot preparation. Its solubility in water is 30 mg/L at 25° C and its melting point is at least 164°C. There is no available analytical test method for dichlorophen or dichlorophen salt.

Dichlorvos is a contact and stomach insecticide which has penetrant and fumigant action. Dichlorvos is used on crops and as a household and public health fumigant. It is a colorless to amber liquid with an aromatic odor and has a boiling point of 35°C and is soluble in water at room temperature at the rate of 10000 mg/L (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Dicofol is a nonsystemic acaricide which has little insecticidal activity. It is used to control mites on a wide range of crops. The technical product is a brown viscous oil which is practically insoluble in water (Martin and Worthing, 1977). Because dicofol is practically insoluble in water and unaffected by light or moisture it persists in the environment. In the soil, dicofol persists for more than one year (McEwen and Stephenson, 1979). An analytical test method is available at 40 CFR 136.

Dinoseb is a contact herbicide used as a post-emergence annual weed control on peas and cereals. Ammonium and amine salts are the most widely used form of dinoseb. It is an orange-brown liquid with a melting point of 30 to 40°C. Dinoseb is soluble in water at a rate of 100 mg/L (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Dioxathion is a nonsystemic insecticide and acaricide used on livestock for external parasites and on fruit trees and ornamentals. The technical product is a brown liquid which is insoluble in water (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 136.

Disulfoton is a systemic insecticide and acaricide for use in protecting seeds and seedlings. It is applied as a seed or soil treatment. The technical product is a dark yellowish oil with a solubility in water of 25 mg/L at room temperature (Martin and Worthing, 1977). When applied in the granular form, disulfoton is taken up by plahts over an extended period of time. An analytical test method is available at 40 CFR 136.

Diuron is a herbicide used for general weed control on crops such as sugar cane, citrus, pineapple, and cotton. Diuron kills weeds by inhibiting photosynthesis. It is a white, odorless solid with a melting point of 158 to 159°C. Its solubility in water at 25°C is 42 mg/L (Martin and Worthing, 1977). Diuron is persistent and immobile in the soil since it is stable to oxidation and moisture (McEwen and Stephenon, 1979). An analytical test method is available at 40 CFR 136.

Ethalfluralin is a pre-plant herbicide which kills germinating weeds; however, weeds which are established are tolerant. In soil, ethalfluralin has residual action on broad-leaved and annual grass weeds in cotton, dry beans, and soybeans. The pure compound is a yellow-orange crystalline solid with a melting point of 55 to 56°C, its solubility in water is 0.2 mg/L (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Ethion is a nonsystemic insecticide and acaricide used on both plants and animals. Specifically, it is used on such crops as citrus, deciduous fruit, tea, and some vegetables (Vettorazzi, 1979). Ethion is a white to amber-colored liquid which is only slightly soluble in water (Martin and Worthing, 1977). Ethion is persistent in the soil for several months (McEwen and Stephenson, 1979). An analytical test method is available at 40 CFR 136.

Ethoprop is a nonsystemic, nonfumigant nematicide and soil insecticide used on many crops. It is a clear, pale yellow liquid with a boiling point of 86 to 91°C. Ethoprop is soluble in water at a rate of 750 mg/L (Martin and Worthing, 1977). There is no analytical test method available for ethoprop.

Etridiazole is a fungicide used for control of some soil-borne diseases of turf and ornamentals. It is also used as a seed treatment for pre- and post-emergence cotton seedling diseases. The technical product is a reddish-brown liquid which is practically insoluble in water. An analytical test method is available at 40 CFR 455.

Fensulfothion is an insecticide and nematicide applied to soil and has long persistence and some systemic activity. Fensulfothion can penetrate plant tissue. It is an oily yellow liquid with a boiling point of 138 to 141°C. Fensulfothion is only slightly soluble in water with a rate of 1500 mg/L at 25 °C (Martin and Worthing, 1977). Fensulfothion persists in the soil for months. An analytical test method is available at 40 CFR 455.

Fenthion is a contact and stomach insecticide with penetrating action used against fruit flies, leaf hoppers, and cereal bugs. The technical product is a brown, oily liquid with a weak garlic odor. Fenthion is soluble in water at room temperature at a rate of 54 mg/L to 56 mg/L (Martin and Worthing, 1977). Fenthion persists in the soil for several months (Vettorazzi, 1979). An analytical test method is available at 40 CFR 455.

Fenuron is a herbicide which is absorbed through roots and acts by inhibiting photosynthesis. It is used especially on woody plants. Fenuron is a white, odorless crystalline solid with a melting point of 133 to 134°C. Its solubility in water is 3850 mg/L at 25°C. An analytical test method is available at 40 CFR 136.

Fenuron-TCA is a mixture of the two herbicides, fenuron and TCA. It is recommended for the control of woody plants on noncrop areas. Fenuron-TCA is a white, odorless crystalline solid with a melting point of 65 to 68°C. Its solubility in water is 4800 mg/L at room temperature. An analytical test method is available at 40 CFR 136.

Ferbam is a fungicide used mainly for the protection of foliage by spraying. It is a black powder with a solubility in water of 130 mg/L at room temperature (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Fluometuron is a herbicide with weak foliar activity which can be absorbed through roots. It is used for control of broad-leaved and grass weeds. Fluometuron is in the form of white crystals with a melting point of 163 to 164.5°C. Its solubility in water at 20°C is 105 mg/L (Martin and Worthing, 1977). An analytical test method is aailable at 40 CFR 455.

Glyphosate is a relatively nonselective, post-emergent herbicide used on annual and perennial grasses, sedges, and broad-leaved weeds. It is a white solid that melts with decomposition at 230°C. Its solubility in water is 12000 mg/L at 25°C (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Hexazinone is a post-emergence contact herbicide used against many annual, biennial, and perennial weeds. It is a white, odorless, crystalline solid with a melting point of 115 to 117 °C. Hexazinone is soluble in water at a rate of 33000 mg/L at 25 °C (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Isodrin a diene-organochlorine insecticide which is stable in soil and relatively stable to the ultra violet action of sunlight. It's chemistry and uses are similar to chlordane, aldrin, dieldrin and heptachlor. An analytical test method is available at 40 CFR 136.

Isopropalin is a pre-plant herbicide incorporated in the soil for direct seeded tomatoes. It is a red-orange liquid with a solubility in water of 0.1 mg/L. An analytical test method is available at 40 CFR 455.

KN methyl is a fungicide. An analytical test method is available at 40 CFR 455.

Linuron is a selective pre- and post-emergence herbicide which inhibits photosynthesis. It is used on soybeans, cotton, potatoes, carrots, and winter wheat. Linuron is a white odorless crystalline solid with a melting point of 93 to 94°C. Its solubility in water is 75 mg/L at 25°C (Martin and Worthing, 1977). Linuron decomposes slowly in soil, persisting up to 4 months (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 136.

Malathion is a nonsystemic insecticide and acaricide. It can be phytotoxic to cucumber, string bean, and squash. Malathion has a wide range of uses including agricultural, horticultural, and household pest. It is a clear, amber liquid with a boiling point of 156 to 157°C. Its solubility in water is 145 mg/L at room temperature (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 136.

Mancozeb is a protective fungicide used against a wide range of foliage diseases. It is a greyish-yellow powder and is practically insoluble in water (Martin and Worthing, 1977).

An analytical test method is available at 40 CFR 455.

Maneb is a protective fungicide used against many foliage diseases in potatoes and tomatoes. It is a yellow crystalline solid which is only slightly soluble in water (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Mephosfolan is a contact and stomach insecticide which demonstrates systemic activity following root or foliar absorption. It is used on such crops as cotton, vegetables, fruit, and field crops. It is a yellow to amber liquid with a boiling point of 120°C. Mephosfolan is moderately soluble in water (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Metham is a soil fungicide, nematicide, and herbicide which has fumigant action. It decomposes to the active component methyl isothiocyanate. Metham is phytotoxic and is persistent in soil for approximately two weeks. It is a white, crystalline solid with a solubility in water of 722000 mg/L at 20°C (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Methiocarb is a nonsystemic insecticide and acaricide with a broad range of action which includes effectiveness in killing snails. It is also used as a bird repellent by seed dressing. Methiocarb is a white crystalline powder with a melting point of 117 to 118°C. It is practically insoluble in water. An analytical test method is available at 40 CFR 136.

Methomyl is used for control of many insects by foliar application and has systemic action when incorporated in the soil. It is a white crystalline solid with a slight sulphurous odor. The melting point is 78 to 79°C. Methomyl is soluble in water at a rate of 58 g/l at 25°C (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Methoxychlor is a nonsystemic contact and stomach insecticide. It has been recommended for fly control in dairy barns, and is used on many crops near harvest time (McEwen and Stephenson, 1979). Methoxychlor is a grey, flaky powder which is practically insoluble in water (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 136.

Metribuzin is a herbicide used in soybeans, potatoes, tomatoes, and other crops. The technical product is white to yellowish and crystalline, and its solubility in water is 1200 mg/l at 20°C (Martin and Worthing, 1977). An analytical test methods is available at 40 CFR 455.

Mevinphos is a volatile contact and systemic insecticide and acaricide used against sap-feeding insects, mites, beetles, and caterpillars. The technical product is a pale yellow to orange liquid with a mild odor. The boiling point is 99 to 103°C. Mevinphos is soluble in water (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Mexacarbate is used as a molluscicide and has a solubility of 100 mg/L at 25°C. Its melting point is 85°C (Windholz, 1976). An analytical test method is available at 40 CFR 136.

Mirex is a stomach insecticide with little contact activity. Its widest use has been against fire ants. Mirex is a white solid which is practically insoluble in water (Martin and Worthing, 1977). An analytical test metnod is available at 40 CFR 136.

Monuron is a herbicide which is absorbed by roots and is an inhibitor of photosynthesis. It is used on noncrop land such as rights-of-way, industrial sites, and drainage ditches. Monuron is a white odorless crystalline solid with a melting point of 174 to 175°C. Its solubility in water is 230 mg/L at 25°C. An analytical test method is available at 40 CFR 136.

Monuron-TCA is a general herbicide used for total weed control in uncropped areas such as rights-of-way, industrial sites, and drainage ditches. Monuron-TCA is a crystalline solid with a melting point of 78 to 81°C. Its solubility in water is 918 mg/L at room temperature. An analytical test method is available at 40 CFR 136.

Nabam is a protective fungicide which, when applied to the soil, has systemic action. Nabam is too phytotoxic to be applied to foliage. It exists in the form of colorless crystals. Nabam is very soluble in water and forms a yellow solution (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Naled is a fast-acting nonsystemic contact and stomach insecticide and acaricide with fumigant action. It is recommended for use in greenhouses, mushroom houses, and against adult mosquitoes and flies on crops. Naled is a yellow liquid with a slightly pungent odor and a boiling point of 110°C. It is practically insoluble in water (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Neburon is a pre-emergence herbicide which is absorbed through roots and acts by inhibiting photosynthesis. It is recommended for control of annual weeds and grasses in wheat, strawberries, and nursery plantings of certain woody ornamentals. Neburon is a white, odorless, crystalline solid with a melting point of 102°C to 103°C. Its solubility in water is 4.8 mg/L at 24°C. An analytical test method is available at 40 CFR 136.

Niacide is a fungicide. An analytical test method is available at 40 CFR 455.

Oxamyl is a contact-type insecticide with residual action. It is applied to foliage and soil. In plants, oxamyl translocates in both an upward and downward direction. Oxamyl is applied to soil to control nematodes and to foliage to control a variety of insects. Oxamyl is a white, crystalline solid with a slight sulphurous odor. Its melting point is 100°C to 102°C and is soluble in water at a rate of 280,000 mg/L at 25°C (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Parathion ethyl and Parathion methyl are nonsystemic contact and stomach insecticides which have some fumigant action. They are used as a household spray for ants and cockroaches (McEwen and Stephenson, 1979). Parathion methyl is a white-crystalline powder with a melting point of 35 to 36°C. Approximately 60 mg/L of parathion methyl is soluble in water at 25°C. The technical product is a light to dark tan liquid (Martin and Worthing, 1977). Analytical test methods for both parathion ethyl and parathion methyl are available at 40 CFR 136.

PCNB (pentachloronitrobenzene) is a fungicide used for seed and soil treatment. It exists in the form of colorless needles with a melting point of 146°C. PCNB is practically insoluble in water (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 136.

PCP salt exists in the form of buff flakes with a solubility in water of 330,000 mg/L at 25°C (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 136.

Perthane is a nonsystemic insecticide with specific applications. It is recommended for use against pear psylla, leaf hoppers, and various larvae on vegetable crops. Perthane is also used to control clothes moths and carpet beetles. The technical product is a wax with a melting point above 40°C and is .pa practically insoluble in water. Perthane is of moderate persistence in soil.

An analytical test method is available at 40 CFR 136.

Phorate is a systemic and contact insecticide and acaricide used to protect crops such as root and field crops, cotton, and coffee. It is also used as a soil insecticide on corn and sugar beets. Phorate is a clear liquid with a boiling point of 118 to 120°C. Its solubility in water is 50 mg/L at room temperature (Martin and Worthing, 1977). Phorate is very persistent in the environment. It has been shown that carrots are capable of taking up and storing large quantities of phorate (Vettorazzi, 1979). An analytical test method is available at 40 CFR 455.

Profluralin is a preplant herbicide applied to soil. It is used to control annual and perennial weeds and grasses in cotton, soybeans, and other crops. It is a yellow-orange crystalline solid with a melting point of 32°C. Its solubility in water is 0.1 mg/L at 20°C. An analytical test method is available at 40 CFR 136.

Prometon is a nonselective herbicide for the control of annual and perennial broad-leaved and grass weeds. Prometon is a white crystalline solid with a melting point of 91 to 92 °C. Its solubility in water is 750 mg/L at 20°C. An analytical test method is available at 40 CFR 136.

Prometryn is a pre- and post-emergence herbicide which is used for selective weed control in cotton, peas, carrots, celery, and potatoes. It is a white crystalline solid with a melting point of 118 to 120°C. Prometryn is soluble in water at a rate of 48 mg/L at 20°C. An analytical test method is available at 40 CFR 136.

Propachlor is a pre-emergence herbicide used against annual grasses and certain broad-leaved weeds in corn, cotton, soybeans, and several other vegetable crops. It is a light tan solid with a melting point of 67 to 76°C. Propachlor is soluble in water at a rate of 700 mg/L at 20°C. Propachlor persists in the soil from 4 to 6 weeks (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Propazine is a pre-emergence herbicide used against broad-leaved and grass weeds in millet and carrots. It is in the form of colorless crystals with a melting point of 212 to 214°C. Propazine is soluble in water at a rate of 8.6 mg/L at 20 °C. An analytical test method is available at 40 CFR 136.

Propham is a selective pre-planting, pre-emergence, and post-emergence herbicide used mainly for the control of annual grass weeds in peas and beets. It is absorbed by roots and acts by inhibiting cell mitosis (Vettorazzi, 1979). It exists in the form of white crystals with a melting point of 87 to 87.6°C. Prophams' solubility in water has been reported at various rates including 32 mg/L, 100 mg/L, and 250 mg/L from 20 to 25°C (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 136.

Propoxur is a nonsystemic insecticide with rapid knock-down power. It is used extensively on field crops, fruits, and vegetables, and in the household against flies and cockroaches. Propoxur has some systemic action in plants. It is a white crystalline powder with a faint odor and a melting point of 84 to 87°C. Propoxur is soluble in water at a rate of 2000 mg/L at 20°C (Martin and Worthing, 1977). Propoxur has residual activity for several weeks when applied indoors (McEwen and Stephenson, 1979). An analytical test method is available at 40 CFR 136.

Ronnel is a systemic insecticide which is used as a residual spray for flies and other household pests. It is also used as a spray for control of ectoparasites of livestock, poultry, and household pets. Ronnel is a white, crystalline powder with a melting point of 40 to 42°C. Its solubility in water is 40 mg/L (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Secbumeton is a herbicide. It is a colorless powder with a melting point of 86°C. Its solubility in water is 600 mg/L at 20°C. It is taken up by leaves and roots and controls mono- and di-cotyledonous weeds. An analytical test method is available at 40 CFR 136.

Siduron is a selective herbicide which is used to control crabgrass and annual weed grasses. It is a white, odorless, crystalline, solid with a melting point of 133 to 138°C.

Siduron is soluble in water at a rate of 18 mg/L at 25°C. An analytical test method is available at 40 CFR 136.

Silvex are hormone-type herbicides which are absorbed by leaves and stems and demonstrate translocation properties. They are used for control of brush submergent and emergent aquatic weeds, and weed control for certain crops. Silvex is a white powder which is soluble in water at a rate of 140 mg/L at 25 °C. An analytical test method for silvex and its salts and esters is available at 40 CFR 136.

Simazine is a pre-emergence herbicide used for the control of broad-leaved and grassy weeds in deep-rooted crops such as citrus, deciduous fruits, and olives. It is a white crystalline solid with a melting point of 225 to 227°C. Simazine is soluble in water at a rate of 5 mg/L at 20 to 22°C.

An analytical test method is available at 40 CFR 136.

Simetryne is a herbicide which is used in combination with S-4-chlorobenzyl diethyldithiocarbamate to control woodleafed weeds in rice. It is in the form of white crystals with a melting point of 82 to 83°C. Simetryne is soluble in water at a rate of 450 mg/L at room temperature. An analytical test method is available at 40 CFR 455.

Stirofos is a selective insecticide used to kill insects on fruit, rice, cotton, corn, and other vegetables. The technical product is a white crystalline solid with a solubility in water of 11 mg/L at 20°C. An analytical test method is available at 40 CFR 40 CFR 455.

Strobane is a poly-chloroterpene insecticide which is semipersistent in soil and disappears from the surfaces of most plant tissue within 3 to 4 weeks. Its chemistry and use is similar to toxaphene. An analytical test method is available at 40 CFR 136.

SWEP is a pre- and post-emergence herbicide used to control seedlings of annual weeds and grasses in rice and large-seeded legumes. It is a white solid with a melting point of 112 to 114°C. SWEP is practically insoluble in water. An analytical test method is available at 40 CFR 136.

2,4,5-T is a herbicide used to kill woody plants. It is applied as a foliage, dormant shoot, or bark spray. Two methods of application of 2,4,5-T are girdling and direct plant injection. 2,4,5-T acid exists in the form of white crystals with a solubility in water of 278 mg/L at 25°C. 2,4,5-T salts are water soluble; however, esters of 2,4,5-T are insoluble in water (Martin and Worthing, 1977). An analytical test method for 2,4,5-T, its salts and esters, is available at 40 CFR 136.

Terbacil is a herbicide which acts as an inhibitor of photosynthesis. It is absorbed by roots and translocates to leaves. Terbacil is used for control of many annual and some perennial weeds in crops such as sugar cane, apples, peaches, citrus, and mint. It is a white crystalline solid with a solubility in water of 710 mg/L at 25°C. Terbacil is persistent in the soil and has an average half-life of several months (McEwen and Stephenson, 1979). An analytical test method is available at 40 CFR 455.

Terbufos is a soil-applied insecticide with residual action. It is used on cotton, sugar beets, cabbage, and onions. The technical product is a clear, colorless to pale yellow liquid with a boiling point of 69°C. Terbufos is soluble in water at a rate of 10 mg/L to 15 mg/L at room temperature. An analytical test method is available at 40 CFR 455.

Terbuthylazine is a herbicide which is taken up by roots and controls a wide range of weeds. It is used as a pre-emergence herbicide in sorghum and for selective weed control in corn, vineyards, and citrus. Terbuthylazine is a white solid which is soluble in water at a rate of 8.5 mg/L at 20°C. An analytical test method is available at 40 CFR 136.

Terbutryn is a selective pre- and post-emergence herbicide for use on winter cereals, sunflowers, potatoes, and peas. It is a white powder with a melting point of 104 to 105°C. Terbutryn is soluble in water at a rate of 58 mg/L at 20°C (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Triademefon is a systemic fungicide which has protective action. It is used against mildew and rusts on vegetables, cereals, coffee, and grapes. Triademefon is a colorless solid with a melting point of 83.3°C. Its solubility in water is 250 mg/L at 20 C (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Tributyltin benzoate is a fungicide used mainly on leather and textiles (Packer, 1975). An analytical test method for tin is available at 40 CFR 136.

Tributyltin oxide is a fungicide used in lumber, paint, plastics, and fabrics (Packer, 1975). An analytical test method for tin is available at 40 CFR 136.

Trichloronate is a nonsystemic insecticide. An analytical test method is available at 40 CFR 455.

Tricyclazole is a fungicide used on rice for the control of blast disease. It is a crystalline solid with a melting point of 187 to 188°C. Tricyclazole is soluble in water at a rate of 1600 mg/L at 25°C (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Trifluralin is a pre-emergence herbicide with some post-emergence activity when incorporated in the soil (Martin and Worthing, 1977). It is absorbed by penetrating shoots and roots of young seedlings and inhibits growth in the entire seedling, especially in lateral root formation (McEwen and Stephenson, 1979). It is used to control broad-leaved weeds and annual grasses in cotton legumes, beans, and orange trees. Trifluralin is an orange, crystalline solid with a melting point of 48.5 to 49°C. Its solubility in water is less than 1 mg/L at 27°C (Martin and Worthing, 1977). Trifluralin is very persistent in the environment due to its immobility in soil caused by its low solubility in water and tendency to absorb to soil particles (McEwen and Stephenson, 1979). Trifluralin is persistent in soil up to 1 year (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Vancide 51Z and Vancide 51Z dispersions are fungicides which contain zinc. An analytical test method for zinc is available at 40 CFR 136.

ZAC is a nonsystemic fungicide used for foliage application. An analytical test method is available at 40 CFR 455.

Zineb is a fungicide used to protect foliage and is phytotoxic to zinc-sensitive plants. Zineb is a light-colored powder which is soluble in water at a rate of 10 mg/L at room temperature (Martin and Worthing, 1977). An analytical test method is available at 40 CFR 455.

Ziram is a protective fungicide used on fruit and vegetable crops and is phytotoxic to zinc-sensitive plants. Ziram is a white, odorless powder with a melting point of 240°C. Its solubility in water is 65 mg/L at 25°C (Martin and Worthing, 1977). The acute oral LD50 for rats is 1,400 mg/kg. An analytical test method is available at 40 CFR 455.

Table IX-1. Pollutants of Primary Significance

Priority Pollutants	Nonconventional Pollutants	Conventional Pollutants
Volatile Aromatics	Nonconventional pesticides listed in Tables XIII-3 and are designated nonconventional pollutants of primary significance	BOD
Benzene		TSS
Chlorobenzene		pH
Toluene		
Halomethanes		
Carbon tetrachloride		
Chloroform	COD	
Methyl bromide		
Methyl chloride		
Methylene chloride		
Cyanides		
Cyanides		
Phenols		
2,4-Dichlorophenol		
2,4-Dinitrophenol		
4-Nitrophenol		
Phenol		
Metals		
(Arsenic Cadmium)		
Copper		
Mercury		
Zinc		
Chlorinated Ethanes		
1,2-Dichloroethane		
Tetrachloroethane		
Nitrosamines		
N-nitrosodi-n-propylamine		
Pesticides		
BHC-alpha		
BHC-beta		
BHC-delta		
Endosulfan-alpha		
Endosulfan-beta		
Endrin		
Heptachlor		
Lindane (BHC-gamma)		
Toxaphene		
Dienes		
Hexachlorocyclopentadiene		

Table IX-2. Pollutants of Dual Significance

Priority Pollutants	Nonconventional Pollutants	Conventional Pollutants
Volatile Aromatics	None	None
1,2-Dichlorobenzene*		
1,4-Dichlorobenzene*		
1,2,4-Trichlorobenzene*		
Haloethers		
Bis (2-chloroethyl) ether†		
Dichloropropane and Dichloropropene		
1,3-Dichloropropene†		

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* Classified as a priority pollutant of primary significance and proposed for regulation only if it is manufactured as a final product. Classified as a priority pollutant of secondary significance in other processes and proposed to be excluded from regulation since it is controlled by regulation of chlorobenzene.

† Classified as a priority pollutant of primary significance and proposed for regulation only if it is manufactured as a final product and has zero discharge. Classified as a priority pollutant of secondary significance in other processes and proposed to be excluded from regulation due to a lack of adequate monitoring and control data.

Table IX-3. Pollutants of Secondary Significance

Priority Pollutants	Nonconventional Pollutants	Conventional Pollutants
Volatile Aromatics	Nonconventional pesticides for which approved analytical procedures and/or adequate technical and economic data are not available	None
1,3-Dichlorobenzene		
Ethylbenzene		
Hexachlorobenzene		
Halomethanes		
Bromoform		
Chlorodibromomethane		
Dichlorobromomethane	Ammonia	
Haloethers	Manganese	
Bis(2-chloroethoxy) methane		
Bis(2-chloroisopropyl) ether		
4-Bromophenyl phenyl ether		
2-Chloroethyl vinyl ether		
4-Chlorophenyl phenyl ether		
Phenols		
2-Chlorophenol		
2,4-Dimethylphenol		
4,6-Dinitro-o-cresol		
2-Nitrophenol		
Parachlorometacresol		
2,4,6-Trichlorophenol		
Nitrosubstitued Aromatics		
2,4-Dinitrotoluene		
2,6-Dinitrotoluene		
Nitrobenzene		
Polynuclear Aromatic Hydrocarbons		
Acenaphthylene		
Acenaphthene		
Anthracene		
Benzo(a)anthracene		
Benzo(a)pyrene		
3,4-Benzofluoranthene		
Benzo(ghi)perylene		
Benzo(k)fluoranthene		
2-Chloronaphthalene		
Chrysene		
Dibenzo(a,h)anthracene		
Fluoranthene		
Ideno(1,2,3-cd)pyrene		
Naphthalene		
Phenanthrene		
Pyrene		

Table IX-3. Pollutants of Secondary Significance (Continued, Page 2 of 2)

Priority Pollutants

- Metals
  - Antimony
  - Beryllium
  - Chromium
  - Lead
  - Nickel
  - Selenium
  - Silver
  - Thallium
- Chlorinated Ethanes and Ethylenes
  - Chloroethane
  - 1,1-Dichloroethane
  - 1,1-Dichloroethylene
  - Hexachloroethane
  - 1,1,2,2-Tetrachloroethane
  - 1,2-Trans-dichloroethylene
  - 1,1,1-Trichloroethane
  - 1,1,2-Trichlorothane
  - Trichloroethylene
  - Vinyl chloride
- Nitrosamines
  - N-nitrosodimethylamine
  - N-nitrosodiphenylamine
- Phthalate Esters
  - Bis(2-ethylhexyl) phthalate
  - Butyl benzyl phthalate
  - Diethyl phthalate
  - Dimethyl phthalate
  - Di-n-butyl phthalate
  - Di-n-octyl phthalate

Priority Pollutants

- Pesticides
  - Aldrin
  - Chlordene
  - Dieldrin
  - 4,4'-DDD
  - 4,4'-DDE
  - 4,4'-DDT
  - Endosulfan sulfate
  - Endrin aldehyde
- Dienes
  - Hexachlorobutadiene
- TCDD
  - TCDD
- Miscellaneous
  - Acrolein
  - Acrylonitrile
  - Asbestos
  - 1,2-Diphenylhydrazine
  - Isophorone
- Polychlorinated Biphenyls
  - PCB-1242
  - PCB-1254
  - PCB-1221
  - PCB-1232
  - PCB-1248
  - PCB-1260
  - PCB-1016
- Benzidines
  - Benzidine
  - 3,3'-Dichlorobenzidine
- Dichloropropane and Dichloropropene
  - 1,2-Dichloropropane

SECTION X

ANALYTICAL TEST METHODS

BACKGROUND

Section 304(h) of the Clean Water Act directs the Agency to approve analytical methods for the analysis of pollutants. These methods are used for compliance monitoring and for filing applications for the NPDES program under 40 CFR 122.60(c) and 122.60(i) and the pretreatment program under 40 CFR 403.7(d). Without these methods, there would be no universally applicable procedure for determining the presence and concentration of these pollutants in wastewater.

During the initial data gathering phase in developing these regulations, analytical test methods had been approved (promulgated) by the Agency for the conventional pollutants, some priority pollutants (all metals and some chlorinated organics) and some nonconventional pesticide pollutants, principally chlorinated organic pesticides. The Agency also developed analytical test methods for all organic priority pollutants and proposed those methods for public review and comment on December 3, 1979 (44 FR 69464). However, in November 1982, the Agency did not have proposed or promulgated analytical test methods for 85 nonconventional pesticide pollutants ("NCPs") for which effluent limitations and standards were proposed.

The Agency had acquired data on the presence and concentrations of these pollutants in wastewater at organic pesticide chemicals manufacturing facilities, and data for 24 of the NCPs with no proposed or promulgated analytical method were used to derive effluent limitations and standards (See Table X-1 for a list of these 24 NCPs). Data on these and other NCPs were submitted by the industry; to more fully understand these data, the Agency, in 1982, requested industry to provide the analytical test methods used by industry to generate the data.

TABLE X-1

NCPs Where Data Was Used to Develop Effluent Limitations and Standards But Which Had No Promulgated Method in November 1982

- Alachlor
- Butachlor
- Propachlor
- Hexazinon
- Profluralin
- Bolstar
- Bromacil
- Carbofuran
- Carbendazim
- Dichlorvos
- Femsulfothion
- Fenthion
- Glyphosate
- Methomyl
- Metribuzin
- Meximphos
- Benomyl
- KN Methyl
- DBCP
- Maneb
- Naled
- 2,4-DB
- Stirofos
- Dinoseb

Screening and verification sampling was conducted by the Agency and its contractors at organic pesticide chemicals manufacturing facilities in 1979 and 1980 to acquire data to identify pollutants of concern and verify their presence and concentrations in raw (untreated) and treated wastewater. At that time, only a limited number of analytical test methods for NCPs were available. Accordingly, the Agency directed its contractor, Environmental Science and Engineering, Inc., to develop test methods for those NCPs expected at the facilities scheduled for sampling. None of the data resulting from use of the contractor developed test methods was used in developing effluent limitations guidelines and standards, but it was used to identify NCPs of concern at individual organic pesticide chemical manufacturing facilities.

The Agency has assigned the principle responsibility for developing new analytical methods to its Environmental Monitoring and Support Laboratory at Cincinnati ("EMSL"). During the period 1980-1982, EMSL developed analytical test methods for 55 NCPs. These test methods were, with a few exceptions, tested and validated in at least two matrices, usually reagent water, pesticides manufacturing industry wastewater, and/or POTW wastewater. POTW wastewater typically is more complex than either reagent water or treated industry wastewater.

The EMSL methods were not available during screening and verification sampling, consequently, none of the EMSL developed methods generated data which was used to develop effluent limitations and standards. However, the principle differences between the EMSL developed methods and the industry and contractor methods are (1) the EMSL methods contain more detail about the specific steps to follow, particularly with respect to elimination of possible and unknown interferences, whereas the industry and contractor methods include steps to eliminate the known interferences encountered in the wastewater at the plant which submitted the method; (2) the EMSL methods were tested and validated in at least two different wastewaters, whereas the industry and contractor methods were validated only in the treated industry wastewater; and (3) the EMSL methods include precision and accuracy (P&A) statements, and the method detection limit ("MDL") is determined in at least one matrix as defined at 40 CFR Part 136, whereas the industry and contractor methods may not have much of a P&A statement, and the detection limit is usually estimated based on instrument conditions. In other words the differences are in the amount of detail in the method rather than the chemistry of the methods. Many of the industry methods are very similar to the EMSL methods and the EMSL methods, when applied to the specific industry wastewaters, would not need the clean-up steps necessary to remove interferences when the interferences are not present in the industrial wastewater, or, alternatively, could incorporate a specific cleanup step as part of the normal method. In either case, the EMSL method could become essentially identical to the industry method. Recognizing the variety of wastewaters which could be encountered, the EMSL methods allow flexibility for the analyst to exercise professional judgment to simplify or make minor modifications to the methods to address individual wastewater matrices, so long as the modified methods meet performance criteria incorporated in the methods.

PROPOSED ANALYTICAL TEST METHODS

In response to the Agency's request, in 1982 the industry submitted 45 analytical test methods for the analysis of 53 NCPs. No industry methods were submitted for the analysis of Carbam-S (Dibromochloropropane); Nabam; Niacide; PCP salt (sodium or potassium pentachlorophenate); Ronnel; or Terbutryn. The industry methods typically included analysis for only one or two NCPs (only one method, number 109, included as many as five pollutants). There were generally two industry methods submitted for each pollutant, although in several cases only one industry method was submitted and in some cases three industry methods were submitted. See Table X-2 for the list of industry methods submitted and pollutants which can be analyzed by each method. Note that the industry method for Ethion is very similar to the method the Agency promulgated for Ethion December 1, 1976 (41 FR 52780).

TABLE X-2

Industry Methods Proposed February 1983

Method	Pollutants	Developed By
101	Alachlor, Butachlor, Propachlor	Monsanto, No Date
102	Alachlor, Butachlor, Propachlor	Monsanto, 1979
103	AOP, Zineb, Ziram, ZAC	FMC, No Date
104	Benfluralin, Ethalfluralin, Isopropalin	Eli Lilly, No Date
105	Benomyl, Carbendazim	E.I. duPont, 1981
106	Benomyl, Carbendazim	E.I. duPont, No Date
107	Bentazon	BASF, 1974
108	Bolstar	Mobay, No Date
109	Bromacil, Hexazinone, Oxamyl, Methomyl, Terbacil	E.I. duPont, 1980
110	Busan 40, Busan 85, KN-Methyl	Buckman Laboratories No Date
111	Carbofuran	FMC, No Date
112	Chlorobenzilate	Ciba-Geigy, 1977
113	Chlorpyrrfos, Chlorpyrifos Methyl	Dow Chemical No Date
114	Coumaphos	Mobay, No Date
115	Cyanazine	Ciba-Geigy, 1977
116	Cyanazine, Stirofos	Shell, No Date
117	2,4-DB	Rhodia, Inc. No Date
118	Deet	US EPA, 1973 (Method Not Promulgated)
119	Mevinphos, Dichlorvos, Naled, Stirofos	Shell, No Date
120	Mevinphos, Dichlorvos, Naled, Stirofos	Shell, No Date
121	Dinoseb	Dow, 1973
122	Dinoseb	Vicksburg Chem. Co., No Date
123	Ethion	FMC, No Date
124	Etridiazole	Olin, No Date
125	Fensulfothion	Mobay, No Date
126	Fenthion	Mobay, No Date
127	Glyphosate	Monsanto, No Date
128	Mancozeb	Rohm & Haas, 1976
129	Maneb	E.I. duPont, No Date
130	Mephosfolam, Phorate, Terbufos	American Cyanamid, No Date
131	Metham	Stauffer, No Date

TABLE X-2 continued
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Method	Pollutants	Developed By
132	Methomyl	Shell, No Date
133	Methomyl	Vertac, No Date
134	Mevirphos	Amyac, No Date
135	Profluralin	Ciba-Geigy, 1977
136	Simetryn	Ciba-Geigy, 1977
137	Triademefon	Mobay, No Date
138	Trichloromate	Mobay, No Date
139	Tricyclazole	Eli Lilly, No Date
140	Glyphosate	Monsanto, 1980
141	Hexazinome, Terbacil, Bromacil	E.I. duPont, 1980
142	Ziram	Fike Chemicals, 1982
143	Propachlor	Dow, No Date
144	Fluometuron	Ciba-Geigy, 1982
145	Metribuzin	Mobay, No Date

TABLE X-III
Contractor Methods Proposed February 1983

Method	Pesticide
401	AOP
401	Ferbam
401	Niacide
401	ZAC
401	Zineb
401	Ziram
402	Benomyl
402	Carbendazim
403	Carbofuran
404	Chlorobenzilate
404	Terbutyrn
404	Profluralin
405	2,4-DB
405	2,4-DB Isobutyl Ester (2,4-DB IBE)
405	2,4-DB Isoctyl Ester (2,4-DB IOE)
406	Dinoseb
407	Dinoseb
408	Methomyl
409	Cyanazine

The Agency's contractor developed nine analytical test methods for the analysis of 18 NCPs. All but five of these 18 NCPs also had industry methods. (Contractor methods, but not industry methods were available for Ferbam, Niacide, 2,4-DB isobutyl ester; 2,4-DB isooctyl ester; and terbutryn). Most contractor methods included only one NCP, but Method 401 included six NCPs, all of which are dithiocarbamates. The analytical method for all six is based on the reaction of each with caustic to generate carbon disulfide ("CS_2) which is then detected and the amount generated is determined as a measure of the amount of dithiocarbamate in the sample. See Table X-3 for a list of contractor methods submitted and the pollutants of which were analyzed by each method.

EMSL developed 15 analytical test methods for the analysis of 59 NCPs. Most of the 59 NCPs were also included in the industry or contractor methods; however, no EMSL methods are available for five NCPs, (Alachlor, Butachlor, Bentazone, Glyphosate, and Terbufos) and there no industry or contractor methods were submitted for the analysis of seven NCPs (PCP salt, DBCP, Carbophenothion, Ronnel, Carbam S, Dichloofenthion, and Dioxathion. Of these seven, analytical methods had been promulgated for Carbophenothion, Dichlorofenthion, and Dioxathion in December 1976. The promulgated methods were essentially the same as those received from EMSL in 1982).

The Agency proposed all 69 analytical test methods for the analysis of 66 NCPs on February 10, 1983 (48 FR 6250). In its proposal, the Agency stated that in some cases analytical methods from three sources (industry, contractor, and EMSL) were proposed for one NCP. The Agency stated that it presented all available methods for public comment and that it intended to select the most appropriate method or methods for promulgation. The Agency did not intend to propose analytical test methods for NCPs for which an Agency approved method had already been promulgated. However, four test methods were proposed which included only NCPs with promulgated analytical test methods (Methods 123 and 614 for Ethion; Methods 617 and 701 for Carbophenothion; and Method 701 for Dioxathion and Dichlofenthion).

During the comment period for the proposed analytical methods, industry submitted 25 additional analytical methods for the Agency's consideration, several of which were to be in place of methods previously submitted by the industry (104A, 105A, 107A, 116A and B, and 140A), three (102A, 107B, and 107C) were to be in addition to the methods previously submitted, and eight were methods for NCPs not included in the methods previously submitted by industry. The rest of the methods submitted by industry are the 800 series of methods listed below and in Table X-4.

In its June 1984 NOA (49 FR 24492, June 13, 1984), the Agency stated that it was considering promulgating one or more of the 18 "800" series methods submitted by industry (see Table X-4); five of those 800 series methods were rejected by the Agency and were not included in the June 1984 NOA. Those five methods and the reasons they were rejected are:

(a) Method 812 (Prometon) - A thin-layer chromatography method with poor precision and lack of quantitative and qualitative accurcy

(b) Method 813 (Triazines, Total) - The method is non-selective for specific triazine compounds, and has no clean-up step even though it is susceptible to interferences

(c) Method 814 (Atrazine, Simazine, Propazine) - This method is a preliminary write-up of method 409; the full procedure was proposed in February 1983

(d) Method 816 and and Method 818 - Information submitted was insufficient for evaluation. No complete analytical procedures were presented. The available material consisted of letters and other correspondance with a few general experimental details.

Of the revised methods submitted by industry (the "A" and "B" methods such as 104A, etc.) only method 107B was included in the June 1984 NOA as method 817.

TABLE X-4

Methods Proposed June 1984

Method	Pollutant
801	2,4-D
802	Demeton
803	Azinphos methyl
804	Disulfoton
805	Diazinon
806	Parathion methyl
807	Parathion methyl, Parathion ethyl
808	Atrazine
809	Ethoprop
810	2,4-D
811	Dicofol
815	Trifluralin
817	Bentazone (Same as 107B)

Selection of Analytical Methods for Promulgation

The Agency evaluated all 82 analytical methods proposed in February 1983 and June 1984 and each of the modifications received in comments, but the Agency did not evaluate methods 812, 813, 814, 816, and 818. Key factors evaluated were (1) instrumentation required for the method; (2) multianalyte capability; (3) clean-up procedures; (4) performance characteristics (including detection limit, recovery of spikes from samples, precision, interferences, and calibration methodology) (5) holding time and sample preservation; and (6) miscellaneous characteristics including complexity of method, safety hazards, and cost considerations). Each of the methods was reviewed and evaluated by each of several experienced analytical chemists who assigned points to each of the key factors for each method, based on their professional judgment. The point scores for each key factor were then averaged for each reviewer for each method reviewed and then totaled for each method. The total score for each method was tabulated, and the complete table was placed in the public record for the June 1984 NOA. In making its final selection of methods for promulgation, the Agency has used the numerical scores of the evaluation of the methods as a guide to identify items of major deficiencies within each method but has not used the numerical score itself as a selecting criterion. Thus, while most of the selected methods received total scores of 800 or more, whether or not a method received a score of 800 was neither necessary nor a sufficient requirement for selection. The Agency considered the following factors of major importance, for the reasons given following each factor.

First, the analytical methods must be used by pesticide chemicals manufacturers, by pesticide chemicals formulators and packagers, by POTWs, and by State and Federal regulatory agencies. Sample types would include treated pesticide chemicals manufacturing wastewater, treated or untreated wastewater from PFP facilities most of which formulate and package a variety of non-pesticide materials, and both untreated and treated municipal wastewaters, which again would arise from a variety of sources, including many non-pesticide sources. Therefore, the methods must be capable of analyzing accurately a variety of wastewater types ("matrices"). Ideally, the method should include detailed procedures to reduce or eliminate any interferences which may be encountered. Alternatively, the method should include at least information or guidance for reduction or elimination of the most commonly expected interferences, and the flexibility for the analyst to use professional judgment for the analysis of complex matrices.

Second, the effluent limitations and standards applicable to much of the pesticide industry require no discharge of pesticide active ingredients; the facilities so regulated, however, could discharge wastewater, so long as they can demonstrate that the wastewater contains no pesticide active ingredient. That demonstration would involve the analysis of samples representative of the discharge for the presence of pesticide active ingredients. Accordingly, the methods should have a statement of the method detection limit ("MDL") determined in several wastewaters. The MDL is defined at 40 CFR Part 136 Appendix B. The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. The MDL is determined from analysis of a sample in a given matrix containing the analyte. A method that has a statement of the MDL even if the MDL was only determined in reagent water, contains some confidence that an analytical result of "not detected" means the pollutant is not present in the wastewater, at least not above the MDL.

Third, the method should not only contain a statement of the MDL, but should also have a "low" MDL, that is, where two methods exist for the same pollutant, and both have a statement of the MDL, the method with the lowest MDL was considered to be the better method.

Fourth, the method should have a statement of the precision and accuracy (standard deviation of duplicate analysis and percent recovery of spiked samples) for the analytes, in a variety of wastewaters. Using this information, an analyst can determine if the method is being applied properly. Additionally, in some cases modifications to the methods may be necessary to adapt to specific matrices. The analyst needs to have a statement of the precision and accuracy for the unmodified method for comparison to the precision and accuracy found for the method as modified to judge whether the results obtained are adequate.

Finally, the method should be written clearly and completely, so the method may be readily used by analysts who are not dedicated solely to pesticides analyses. The method should have at least general information on safety precautions, reagents and glassware necessary, and calculations needed to generate the final result to be reported. Each of these is important for analysts starting to use an unfamiliar method, but may be easily overlooked in methods normally used for analysis of only one type of wastewater.

Considering all of these factors, the Agency has promulgated 14 analytical test methods for NCPs. These 14 methods are presented in Table X-5. Ten of the 14 analytical test methods are EMSL-developed methods. When compared to the other methods proposed, the EMSL methods were generally more complete, containing detailed sections on safety, reagents and glassware, and calculations. The EMSL methods contained a statement of the MDL in at least one wastewater, the precision and accuracy for at least one wastewater, and were the most sensitive, that is, they have the lowest MDL, when a contractor or industry method had an MDL (usually, neither the contractor nor the industry method provided an MDL). The EMSL methods also provided information on clean-up and separation procedures for the reduction or elimination of interferences. In most cases,such information was absent or extremely brief for the industry and contractor developed methods. Four industry developed methods are promulgated. They are methods 102, 107A, 130, and 140A. In all four cases, no EMSL-developed method was available for the pollutants analyzed by the methods, hence the industry methods were promulgated even though there were some deficiencies in information, so that a method would be available.

RATIONALE FOR SELECTION/REJECTION OF EACH METHOD

This section describes briefly the reason(s) for selecting or rejecting each method.

1. Methods 101, 102, 102A, and 143 for analysis of Alachlor, Butachlor, and Propachlor (Method 143 is for propachlor only). All three methods were submitted by Monsanto. Method 101 is an early version of method 102, which is more complete and more recent than method 101. Method 102A is a method submitted by Monsanto in its comments on the proposed methods. Monsanto requested that method 102A be in addition to method 102, method 102A is not a revision of method 102 but is an entirely different method. Method 102A is more experimental than method 102, hence the Agency did not propose method 102A in the June 1984 NOA because method 102 is believed to be adequate, validated, and with adequate precision, accuracy, and detection limit. Method 143 uses a flame ionization detection ("FID") which is not as sensitive to chlorinated herbicides as the electron capture detection ("ECD") used by method 102. Hence, method 102 was selected and the other three methods were rejected.

2. Methods 103, 110, 128, 129, 131, 142, 401, and 630 for the analysis of AOP, Busan 40, Busan 85, Carbam-S, Ferbam, KN Methyl, Mancozeb, Maneb, Metham, Nabam, Niacide, ZAC, Zineb, and Ziram: these pesticides are all metal dithiocarbamates. Methods 103, 129, 142, 401, and 630 all hydrolyze the dithiocarbamate to CS_2 and measure the amount of CS_2 evolved as a measure of the amount of pesticide in the wastewater. The analytical procedures described in each of those 5 methods is similar, but method 630 clearly applies to all 14 dithiocarbamates, whereas each of the other 4 names only some of the 14 pesticides. Hence, method 630 is the best of the five. Method 110 is a thin-layer chromatography method with poorly defined precision and accuracy, a detection limit of one part per million (ppm) compared to the

0.025 ppm MDL obtained by method 630. Moreover, method 110 is very incomplete; the method does not even describe what reagents to use. Methods 128 and 131 are gas chromatographic (GC) methods for specific dithiocarbamates, one (method 128) uses GC to detect the CS_2 evolved during hydrolysis while the other (method 131) uses GC to detect methyisothiocyanate evolved during hydrolysis. Neither method provides sufficient information on clean-up and separation procedures, likely interferences, or precision and accuracy. Hence, method 630 was selected and the other seven methods were rejected.

3. Methods 104, 104A, 135, 404, and 627 for the analysis of Benfluralin, Ethalfluralin. and Isopropalin (methods 104 and 627), and Profluralin (methods 135, 404, and 627).

Method 135 is a thin-layer chromatography method which is insensitive (detection limit of 6 ppm). Method 404 is imcomplete, with no information on interferences, clean-up procedures, and calculations, and insufficient information on calibration procedures and quality control. Methods 104, 104A, and 627 appear to be similar but method 627 has more complete information on interferences and procedures to reduce or eliminate the interference, and more complete information on MDL, precision and accuracy. In addition, method 627 includes four analytes, method 104 and 104A only three analytes. Therefore, method 627 was promulgated.

4. Methods 105, 105A, 106, 402, and 631 for Benomyl and Carbendazim: All five methods are high performance liquid chromatography ("HPLC") methods. Method 106 is an early version of method 105 which is used at one industrial facility but has not been demonstrated in other wastewaters. Method 402 reports a detection limit of 0.10 ppm and does not contain information on interferences, calibration, quality control, or calculations and therefore must be considered too incomplete and insensitive for general use. Method 105 has a reported detection limit of 0.08 ppm but has no information on interferences and clean-up procedures. Method 631 has a MDL of .009 ppm and includes information on interferences and clean-up procedures. The precision and accuracy were determined in two wastewaters. Therefore, method 631 was promulgated, and methods 105, 106, and 402 were withdrawn.

5. Methods 107, 107A, 107B, and 817 for Bentazon. Method 107A adds more detail to method 107 including some revisions to the procedures to eliminate some interferences. BASF, the submitter of all four methods, requested 107 be withdrawn and replaced with method 107A. BASF also requested methods 107B and 817 be promulgated. Method 817 is significantly different from method 107, and 107A, and 107B and is considerably less sensitive, with a detection limit of 1 ppm. Method 107B is an extension of

methods 107 and 107A in that it uses GC/MS rather than GC with FID, but method 107B does not have complete information on the precision and accuracy that can be obtained whereas method 107A is very similar to method 107 and can be expected to yield equal or better results than those reported for method 107. Therefore, method 107A is promulgated because method 107 was withdrawn by the submitter, method 107B needs more information, and method 817 is insensitive.

6. Methods 108(Bolstar), 113(Chlorpyrifos, Chlorpyrifos Methyl), 114(Coumaphos), 116(Stirofos), 116A(Stirofos), 119(Dichlorvos, Naled, Mevinphos, Stirofos), 120(Dichlorvos, Naled, Mevinphos, Stirofos), 125(Fensulfothion), 126(Fenthion), 134(Mevinphos), 138(Trichloronate), and 622 (Bolstar, Chlorpyrifos, Chlorpyrifos methyl, Coumaphos, Dichlorvos, Fensulfothion, Fenthion, Mevinphos, Naled, Phosate, Ronnel, Stirofos, and Trichloronate). All of these pesticides are organo-phosphorus pesticides. Method 116 is an HPLC method which was withdrawn by the submitter and replaced with Method 116A. Method 116A provides an estimated detection limit of 0.010 ppm for stirofos whereas method 622 has an MDL of 0.005 ppm and is applicable to 13 organophosphorus pesticides while method 116A is applicable to only Stirofos. Methods 108, 114, 120, 125, 126, 134 and 138 have no information on precision and accuracy and contain other information deficiencies as well. Method 113 is incomplete because it does not have information on interferences and has no clean-up and separation procedures. Method 119 has detection limits of .002 to .010 ppm whereas method 622 has MDLs of .0001 to .005 ppm. Accordingly, method 622 is promulgated and methods 108, 113, 114, 116, 119, 120, 125, 126, 134, and 138 are withdrawn.

7. Methods 109 (Oxamyl, Methomyl, Bromacil, Hexazinone, Terbacil), 111 (Carbofuran), 118 (DEET), 132 and 132A (Methomyl), 133 (Methomyl), 137 (Triadimefon), 139 (Tricyclazole), 141 (Bromacil, Hexazinone, Terbacil), 144 (Fluometurom), 145 (Metribuzin), 403 (Carbofuran), 408 (Methomyl), 632 (Carbofuran, Fluometuron, Methomyl, Oxomyl) and 633 (Bromacil, DEET, Hexazinone, Metribuzin, Terbacil, Triadimefon, Tricyclazole).

These pesticides contain nitrogen and are of borderline volatility for analysis by GC, thus the wide variation in methods. Methods 137 for Triadimefon and 144 for Fluometuron are thin-layer chromatography ("TLC") methods which are insensitive and imprecise. Method 111 for Carbofuran does not provide information on interferences, clean-up and separation, detection limit, precision or accuracy. Method 403 for Carbofuran reports a detection limit of 0.025 ppm whereas method 632 has a MDL of 0.004 ppm for Carbofuran. Hence, the Agency promulgated method 632 for Carbofuram, Fluormeturon, Methomyl and Oxamyl. Method 109 does not report detection limits, precision or accuracy for any of the pesticides. Methods 132, 132A, 133, and 408 for

Methomyl have detection limits that are too high (0.10 ppm, 0.010 ppm 0.10 ppm, and 1 ppm respectively) and have incomplete information on interferences clean-up and separation procedures.

Method 118 for DEET is incomplete because it does not have information on interferences, calibration, clean-up and separation, calculations, detection limit, precision or accuracy. Method 139 does not have information on interferences and clean-up and separation procedures, and has been tested in only one wastewater. Method 141 also does not have information on interferences, clean-up and separation procedures, and each of the three pesticides requires different instrument conditions. Method 145 for metribuzin does not provide detection limits, precision or accuracy information. Method 633 has MDL of 0.004 ppm or less and has been tested by EPA in two wastewaters. In addition, one commenter tested the method extensively and reported excellant, reproducable results. Accordingly, Method 633 is promulgated. Methods 109, 111, 118, 132, 133, 137, 139, 141, 144, 145, 403 and 408 are withdrawn.

8. Methods 112 (chlorobenzilate), 124 (Etridiazole), 404 (Chlorobenzilate, Terbutryn, and Profluralin), and 608.1 (Chlorobenzilate, Etridiazole, Propachlor, and DBCP). Method 112 is a TLC method that is insensitive and imprecise. Method 124 has no information on interferences, clean-up and separation, detection limit, or precision and accuracy. Method 404 has no information on interferences, precision or accuracy, and has a detection limit of 0.2 ppm. Method 608.1 has a MDL of 0.001 ppm or less. Therefore, method 608.1 is promulgated and methods 112, 124, and 404 are withdrawn. (Note that method 102 is also promulgated for the analysis of propachlor).

9. Methods 115, 116, 116A, 409, and 629 for Cyanazine. Method 115 is a TLC method that is too insensitive and imprecise. Method 116 was withdrawn by the submitter and replaced by method 116A. Method 116A has a detection limit of 0.050 ppm, Method 409 has a detection limit of 0.14 ppm, whereas Method 629 has a MDL of 0.006 ppm and has been tested in four different wastewaters. Therefore, the Agency is promulgating method 629 and withdrawing methods 115, 116, and 409.

10. Method 117(2,4-DB), 121(Dinoseb), 122(Dinoseb), 405 (2,4-DB, 2,4-DB isobutyl ester, 2,4-DB isoctyl ester), 406(Dinoseb), 407 (Dinoseb) and 615 (2,4-DB, 2,4-DB esters, and Dinoseb). These chlorinated herbicides are best determined by GC/ECD (electron captive detectors). Methods 117, 122, 406, and 407 are too insensitive, with detection limits of 1 ppm, 0.1 ppm, 0.2 ppm, and 0.2 ppm, respectively. Method 121 does not include information on interferences, clean-up and separation, detection limit, or precision and accuracy. Method 615 includes that information and has MDLs of 0.001 ppm or less. Therefore, the

Agency is promulgating method 615 and withdrawing methods 117, 121, 122, 405, 406, and 407.

11. Methods 123(Ethion), 614 (Ethion), 617 (Carbophenothion), 701 (Dichlofenthion, Dioxathion, Carbophenothion), 801 (2,4-D), 802(Demeton), 803 (Azinphos Methyl), 804 (Disulfoton), 805 (Diazinon), 806(Parathion Methyl), 807 (Parathion Methyl, Parathion Ethyl), 808 (Strobane), 810 (2,4-D), 811 (Dicofol), and 815 (Trifluralin). All these methods include only NCPs for which analytical test methods were promulgated in December 1976. The Agency had not intended to propose alternate methods for those methods. Therefore, the Agency is withdrawing them under 40 CFR Part 455.

12. Methods 127, 140, and 140A - Glyphosate. All three methods were developed by Monsanto. Method 127 is an early version of method 140. Monsanto developed method 140 using a synthetic wastewater. Monsanto reported in its comments on the proposed analytical methods that the use of method 140 on actual treated wastewater did not give reproducible results because a clean-up step was necessary to eliminate interferences. Method 140A includes this clean-up step. Accordingly, the Agency is promulgating method 140A because it supercedes method 140, which Monsanto determined could not be applied to real wastewater, and the Agency is also withdrawing method 127 because it also has been superceded by method 140A.

13. Method 130 (Mephosfolan, Phorate, and Terbufos)

There are no other methods available for Mephosfolan or Terbufos, and Method 130 includes information on interferences and reports a detection limit of .005 to 0.025 ppm using an aklaki-flame ionization detector. The method does not include precision and accuracy information, however; good quality control and maintenance of records is essential. Note that method 622 has also been promulgated for analysis for Phorate.

14. Methods 136 (Simetryne) and 619 (Simetryne, Terbutryn). Method 136 is a TLC method that is insensitive and imprecise. Method 619 has a MDL of 0.00007 ppm or less, and has been tested in two wastewaters. Therefore, the Agency is promulgating method 619 and withdrawing method 136.

15. Method 809-Ethoprop. This method is not a water method but instead is a method for determining the purity of the pesticide. The method uses a 1 gram sample, which is about 1 milliter. That small a volume cannot be accurately analyzed for trace quantities by the method as written.

16. Method 604 and 625 for PCP salt. These two methods were promulgated as part of 40 CFR Part 136 on October 26, 1984 (49 FR 43234). Therefore, they are not promulgated as part of 40 CFR Part 455.

The analytical test methods promulgated at 40 CFR 455 are shown in Table X-5. Table X-6 presents the analytical test methods for NCPs promulgated at 40 CFR 136. Table X-7 presents priority pollutant pesticides, all of which have analytical test methods promulgated at 40 CFR 136.

TABLE X-5

Analytical Test Methods Promulgated at 40 CFR 455

Method	Pollutants
102	Alachlor, Butachlor, Propachlor
107A	Bentazon
130	Mephosfolan, Phorate, Terbufos
140A	Glyphosate
608.1	Chlorobenzilate, Etridiazole, Propachlor, DBCP
615	2,4-DB; 2,4-DB isobutyl ester; 2,4-DB isooctyl ester; Dinoseb
619	Simetryn, Terbutryn
622	Bolstar, Chlorpyrifos, Chlorpyrifos Methyl, Coumaphos, Dichlorvos, Fensulfothion, Fenthion, Mevinphos, Naled, Phorate, Ronnel, Stirofos, Trichloronate
627	Benfluralin, Ethalfluralin, Isopropalin, Profluralin
629	Cyanazine
630	AOP, Busan 40, Busan 85, Carbam-S, Ferbam, KN Methyl, Mancozeb, Maneb, Metham, Nabam, Niacide, ZAC, Zineb, Ziram
631	Benomyl, Carbendazim
632	Carbofuran, Fluometuron, Methomyl Oxamyl
633	Bromacil, Deet, Hexazinone, Metribuzin, Terbacil, Triadimefon, Tricyclazole

TABLE X-6

NCPs With Analytical Test Methods Promulgated at 40 CFR 136

1. Ametryn
2. Aminocarb
3. Atraton
4. Atrazine
5. Azinphos methyl
6. Barban
7. Captan
8. Carbaryl
9. Carbophenothion
10. Chloropropham
11. 2,4-D and its esters & salts
12. Demeton-O
13. Demeton-S
14. Diazinon
15. Dicamba
16. Dichlofenthion
17. Dichloram
18. Dicofol
19. Dioxathion
20. Disulfoton
21. Diuron
22. Ethion
23. Fenuron
24. Fenuron-TCA
25. Isodrin
26. Linuron
27. Malathion
28. Methiocarb
29. Methoxychlor
30. Mexacarbate
31. Mirex
32. Monuron
33. Monuron-TCA
34. Neburon
35. Parathion methyl
36. Parathion ethyl
37. PCNB
38. Perthane
39. Prometon
40. Prometryn
41. Propazine
42. Propham
43. Propoxur
44. Secbumeton
45. Siduron
46. Simazine
47. Strobane
48. Swep
49. 2,4,5-T and its esters and salt
50. 2,4,5-TP(Silvex) and its esters and salts
51. Terbuthylazine
52. Trifluralin

TABLE X-7

Priority Pollutant Pesticides Analytical Test Methods Promulgated at 40 CFR 136

1. Aldrin
2. alpha-BHC
3. beta-BHC
4. delta-BHC
5. gamma-BHC (Lindane)
6. 4,4'-DDD
7. 4,4'-DDE
8. 4,4'-DDT
9. Dieldrin
10. Endosulfan I
11. Endosulfan II
12. Endosulfan Sulfate
13. Endrin
14. Endrin Aldehyde
15. Heptachlor
16. Heptachlor epoxide
17. Toxaphene
18. Chlordane
19. Bis(2-chloroethyl)ether
20. Chlorobenzene
21. 1,2-Dichlorobenzene
22. 1,4-Dichlorobenzene
23. 1,2-Dichloropropane
24. cis-1,3-Dichloropropene
25. trans-1,3-Dichloropropene
26. 1,3-Dichloropropene
27. Dimethyl Phthalate
28. Hexachlorobenzene
29. Methylbromide
30. Napthalene
31. Pentachlorophenol ("PCP") and its salts
32. Trichlorobenzene

SECTION XI

BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

INTRODUCTION

This section describes the best available technology economically achievable (BAT) for the treatment and control of process wastewater generated within the Pesticides Chemicals Category. BAT represents the best existing economically achievable performance of plants of various ages, sizes, processes or other shared characteristics.

The Federal Water Pollution Control Act of 1972 required that BAT represent reasonable further progress (beyond BPT) toward eliminating the discharge of all pollutants. In fact, elimination of discharge of all pollutants is required if technologically and economically achievable. The Clean Water Act of 1977 specifically defined both the conventional and toxic pollutants that must be regulated (See Section IX of this document for identification of these pollutants) and also established a class of nonconventional pollutants for regulation.

BAT has been further defined as the very best control and treatment technology within a subcategory or a superior technology transferred from other industrial subcategories or categories. This definition encompasses in-plant process improvements as well as more effective end-of-pipe treatment.

IDENTIFICATION OF BAT

The BAT technologies for the organic pesticide chemicals manufacturing subcategory of physical chemical treatment (steam stripping, pesticide removal, chemical oxidation and/or metals separation) followed by biological treatment are discussed in Section VI of this document. For the 23 priority pollutants and 50 nonconventional pesticides listed in Table XI-1, the BAT technology is physical/chemical treatment followed by biological treatment. For the 9 priority pollutants and 33 nonconventional pesticides listed in Table XI-1, the BAT technology is physical/chemical treatment. As discussed in Section VI, the recommended physical/chemical treatment varies depending upon the specific pollutants associated with a pesticide manufacturing process. Plants manufacturing two priority pollutant and six nonconventional pollutant pesticides do not discharge any wastewaters. The plants manufacturing the six nonconventional pollutant pesticides do not generate any wastewater, therefore there is no treatment technology required. One priority pollutant manufacturer does not generate wastewater and the other employs total evaporation to eliminate a point source wastewater discharge.

The BAT treatment systems (defined in Section VI) are adequate to achieve the BAT effluent limitations. However, a plant may elect to supplement this system with other equipment or use an entirely different treatment technique in order to attain the BAT limitations. Alternative technologies (both end-of-pipe and in-process) are described in Section VI of this document.

RATIONALE FOR SELECTION OF BAT

The BAT treatment system identified previously was selected because it has been proven in pesticides plants to represent a well demonstrated, reliable technology which achieves a high degree of toxic and nonconventional pesticide pollutant removal. This is demonstrated by the BAT system performance described in Section VI.

Although demonstration of BAT at a single plant is adequate for its selection, the selected BAT technologies are employed at many pesticides plants. Twenty plants currently employ steam stripping, chemical oxidation or metals separation. Twenty-nine plants currently employ adsorption or hydrolysis. Thirty-two plants employ biological treatment. Adsorption onto activated carbon have been demonstrated to be effective at 17 plants, although far less frequently than the identified BAT technologies.

The costs and nonwater quality environmental aspects of these technologies are presented in Section VIII.

The BAT effluent limitations guidelines for subcategory 1 are presented in Section XIV.

The development of these effluent limitations from performance measurements of existing BAT systems is described in Section XIV. The statistical rationale used in developing these limitations is presented in Section XIV and expanded in a separate report entitled "Limitations and Standards Methodology for the Pesticide Chemicals Industry, August 10, 1985.

The Agency is not promulgating BAT for the metallo-organic pesticide chemicals manufacturing or the pesticide chemicals formulating and packaging subcategories but instead is excluding these two subcategories from further national BAT regulation development under paragraph 8(a)(i) of the *NRDC v. Train* consent decree because effluent limitations guidelines no more stringent than BPT could be established. BPT for both subcategories requires no discharge of process wastewater pollutants.

BENEFITS OF BAT IMPLEMENTATION

The estimated environmental benefits of the application of the selected BAT model technology is the removal of 0.74 million kg/yr (1.63 million lb/yr) of pollutants from current discharge, including 0.42 million kg/yr (0.92 million lb/yr) of priority pollutants.

TABLE XI-1

MODEL TREATMENT TECHNOLOGY FOR BAT

Treatment Technology	Priority Pollutants	**Non-Conventional Pesticides
(1) Physical/Chemical Treatment Technology		Busan 40 Busan 85 Carbam-S Carbophenthion Chlorpropham Chlorpyrifos Chlorpyrifos-methyl Coumaphos DBCP Dioxathion Ferbam KN-methyl Mancozeb Maneb Metham Niacide PCNB PCP salt Ronnel Silvex Stirofos Swep Trichloronate ZAC Zineb 2,4-D 2,4-D IB ester 2,4-D IO ester 2,4-DB 2,4-DB IB ester 2,4-DB IO ester 2,4,5-T
(2) Physical/Chemical Plus Bio Treatment Technology	1,2-Dichlorobenzene 1,4-Dichlorobenzene 1,2,4-Trichlorobenzene Methyl bromide Carbon tetrachloride Chloroform Methyl chloride Methylene chloride Cyanide 2,4-Dichlorophenol 2,4-Dinitrophenol 4-Nitrophenol Pentachlorophenol Copper Zinc N-Nitrosodi-n-propylamine Hexachlorocyclopentadiene Benzene Chlorobenzene Toluene Phenol 1,2-Dichloroethane Tetrachloroethylene	Alachlor Atrazine Azinphos methyl Benfluralin Benomyl Bolstar Bromacil Butachlor Carbendazim Carbofuran Dematon-O Dematon-S Demeton Diazinon Dichlofenthion Dichlorvos Dinoseb Disulfoton Diuron Ethalfluralin Ethion Fensulfothion Fenthion Fluometuron Glyphosate Isopropalin Linuron Malathion Methomyl Metribuzin Mevinphos Neburon Oxamyl Parathion ethyl Parathion methyl Phorate Profluralin Prometon Prometryn Propachlor Propazine Propham Propoxur Simazine Simetryn Terbacil Terbufos Terbuthylazine Terbutryn Trifluralin

23 Priority Pollutants where BAT = P/C & Bio
2 Priority Pollutants where BAT = No discharge
(1,3-Dichloropropene and Bis (2-Chloroethyl Ether)
** 6 NCP's where BAT = No discharge (Barban, Silvex isooctylester,
Silvex salt, Tributyltin benzoate, Vancide 51Z, Vancide 51Z dispersion)

SECTION XII

NEW SOURCE PERFORMANCE STANDARDS (NSPS)

INTRODUCTION

This section describes the new source performance standards (NSPS) for the treatment and control of process wastewaters generated within the Pesticides Manufacturing Category. NSPS reflects existing treatment and control practices or demonstrations that are not necessarily in common practice.

The Federal Water Pollution Control Act of 1972 required that NSPS represent the best available demonstrated control technology, processes, and operating methods. Where practicable, no pollutant discharge at all is to be allowed. Where pollutant discharge is unavoidable, these standards are to represent the greatest degree of effluent reduction achievable. They apply to new sources, which are defined as any building, structure, facility, or installation that discharge pollutants and for which construction is started after promulgation of the standards.

New direct discharge organic pesticide chemicals manufacturers, and pesticide chemicals formulator/packagers, have the opportunity to design the best and most efficient pesticide processes and wastewater treatment technologies. Therefore, Congress directed EPA to consider the best demonstrated process changes, in-plant controls, and end-of-pipe treatment technologies which reduce pollution to the maximum extent feasible.

NSPS for organic pesticide chemicals manufacturers includes 89 nonconventional pesticide and 34 priority pollutants regulated under BAT, and the conventional pollutants BOD, TSS and pH and COD regulated under BPT. For subcategory 2 the Agency is not promulgating a NSPS pending further analysis of appropriate NSPS technologies. For subcategory 3, NSPS applies to process wastewaters resulting from formulating and packaging of the 147 organic pesticide chemicals which have an available analytical method plus vancide 51Z, vancide 51Z dispersion (which contain zinc), and metallo-organic pesticide chemicals containing arsenic, cadmium, copper, mercury and tin, where the pesticide may be detected by analyzing for the metal.

IDENTIFICATION OF NEW SOURCE PERFORMANCE STANDARDS TECHNOLOGY

Data from existing organic pesticide chemicals manufacturing plants were used to define a model direct discharger for subcategory 1. Average subcategory production and discharge flow rates were used to define the model plant. For subcategory 3, two model new source plants were defined, one based on the average of existing high flow plants and the other based on the average of existing low flow plants.

The technology basis for NSPS for subcategory 1 is physical/chemical treatment followed by biological treatment for 23 priority pollutants and 49 nonconvenitonal pesticide pollutants and physical/chemical treatment alone for 11 priority pollutants and 34 nonconventional pesticide pollutants. These technologies are identical to those selected for BAT. The rationale for selection of these technologies is given in Section IX. The Agency is promulgating effluent limitations based on the BAT technology because no additional technology which removes significant additional quantities of pollutants is known. The NSPS effluent limitations for subcategory 1 are given in Section XIV.

The technology basis for NSPS for subcategory 3 is contract hauling and incineration for all plants except those where the wastewater flows are high enough that physical/chemical treatment and recycle/reuse, with contract hauling and incineration of treatment system residues, is less expensive than contract hauling. This technology is the same as the technology selected for PSES (See Section XIII for the rationale for selecting that technology).

The Agency is promulgating NSPS based on the PSES technology because no additional technology which removes significant additional quantities of pollutants is known. The NSPS require no discharge of process wastewater pollutants in process wastewaters resulting from the formulating and packaging of any of 147 organic pesticide chemicals, Vancide 51Z, Vancide 51Z dispersion, and metallo-organic pesticide chemicals containing arsenic, cadmium, copper, mercury, and tin. (See Section XIII for a list of the 147 organic pesticide chemicals).

SECTION XIII

PRETREATMENT STANDARDS

INTRODUCTION

This section describes the pretreatment standards for existing sources (PSES) and the pretreatment standards for new sources (PSNS) for the treatment of process wastewaters generated within the Pesticide Chemical Subcategories and discharged to publicly owned treatment works (POTW). These standards are intended to provide an equivalent degree of toxic organic pollutant, toxic metal pollutants, and nonconventional pesticide pollutant removal as provided by direct discharge limitations.

The Federal Water Pollution Control Act of 1972 stated that the pretreatment standards shall prevent the discharge to a POTW of any pollutant that may interfere with, pass through, or otherwise be incompatible with the POTW. The Clean Water Act Amendments of 1977 further stipulated that industrial discharges must not interfere with use and disposal of municipal sludges and further that the discharge from the POTW must not be greater than the direct discharge limitations . In accordance with the Clean Water Act, individual POTWs may specify more stringent standards or (after meeting specified criteria) may relax the standards presented here.

IDENTIFICATION OF PRETREATMENT TECHNOLOGY

The pretreatment technology for PSES for the Organic Pesticide Chemicals Manufacturing is presented in Table XIII-1 for each regulated pollutant. The pretreatment technology for PSES for the Metallo-Organic Pesticide Chemicals Manufacturing and Pesticide Chemicals Formulgating and Packaging subcategories are given in Table XIII-2.

RATIONALE FOR SELECTION OF PRETREATMENT TECHNOLOGY

Toxic organic, metals, and nonconventional pesticide pollutants may pass through a POTW or they may contaminate the sludge or they may interfere with the treatment process. These pollutants must therefore be controlled by pretreatment. (See Section V B(3) of the preamble to the regulation).

PRETREATMENT STANDARDS

Pretreatment standards for existing (PSES) and new sources (PSNS) for the organic pesticide chemicals manufacturing subcategory are the same as BAT for all pollutants except six priority pollutants which are not regulated. A detailed discussion as to why these pollutants were not regulated is in the preamble to the final regulation. These standards are given in Section XIV.

The pretreatment standards for the metallo-organic pesticide manufacturing subcategory are the same as the existing BPT limitation of no discharge of process wastewater pollutants from the manufacture of metallo-organic pesticides containing cadmium, arsenic or copper. A discharge standard based on zinc precipitation is specified for the manufacture of mercury metallo-organic pesticides products. These standards are given in Section XV.

The pretreatment standards for the pesticide chemicals formulating and packaging subcategory are no discharge of priority pollutants or the pesticide active ingredients listed in Appendix D of the regulation in process wastewater resulting from the formulating and packaging of any of the pesticide active ingredients listed in Appendix D of the regulation. Appendix D lists 147 organic pesticide chemicals with available analytical test methods and the zinc metal-containing organic pesticide chemicals Vancide 51Z and Vancide 51Z dispersion. Appendix D also includes all metallo-organic pesticide chemicals containing arsenic, cadmium, copper, mercury, or tin.

The Agency is not setting new source pretreatment standards for metallo-organic pesticide producers under paragraph 8(b)(2) of the EPA v. Train Consent Decree. Pretreatment standards for new sources for formulator packagers are the same as pretreatment standards for existing sources.

BENEFITS OF IMPLEMENTATION

The estimated environmental benefits of implementing pretreatment standards for this category are summarized in Section XIV and detailed in a report entitled "Limitations and Standards Methodology for the Pesticide Chemical Industry." Implementation of PSES will remove annually an estimated 150,000 kg/yr (330,000 lb/yr) of pollutants included 93,200 kg/yr (205,000 lb/yr) of priority pollutants.

TABLE XIII-1

MODEL TREATMENT TECHNOLOGY FOR PSES
FOR THE PESTICIDE MANUFACTURING SUBCATEGORY

Treatment Technology	* Priority Pollutants	Non-Conventional Pesticides	
(1) Physical/Chemical Treatment Technology	^{c}1,2-Dichlorobenzene	Busan 40	Ronnel
	^{c}1,4-Dichlorobenzene	Busan 85	Silvex
	^{c}1,2,4-Trichlorobenzene	Carbam-S	Stirofos
	^{c}Methyl bromide	Carbophenthion	Swep
	^{c}Carbon tetrachloride	Chlorpropham	Triazines
	^{c}Chloroform	Chlorpyrifos	Trichloronate
	^{c}Methyl chloride	Chlorpyrifos-methyl	ZAC
	^{c}Methylene chloride	Coumaphos	Zineb
	^{c}2,4-Dichlorophenol	DBCP	2,4-D
	^{c}4-Nitrophenol	Dioxathion	2,4-D IB ester
	^{c}Pentachlorophenol	Ferbam	2,4-D IO ester
	^{c}Copper	KN-methyl	
	^{a}Zinc	Mancozeb	2,4-DB
	^{a}N-Nitrosodi-n-propylamine	Maneb	2,4-DB IB ester
	^{c}Hexachlorocyclopentadiene	Metham	2,4-DB IO ester
	^{b}a-BHC-Alpha	Naled	2,4,5-T
	^{b}b-BHC-Beta	Niacide	
	^{b}d-BHC-Delta	PCNB	
	^{b}g-BHC-Gamma	PCP Salt	
	^{b}a-Endosulfan-Alpha		
	^{b}d-Endosulfan-Beta		
	^{a}Endrin		
	^{a}Heptachlor		
	^{a}Toxaphene		
(2) Physical/Chemical Plus Biological Treatment Technology	Cyanide	^{2}Alachlor	Isopropalin
	2,4-Dinitrophenol	^{2}Atrazine	Linuron
		Azinphos-methyl	Malathion
		Benfluralin	Methomyl
		Bolstar	Metribuzin
		Bromacil	^{2}Mevinphos
		Butachlor	Neburon
		Carbendazim/Benomyl complex	Oxamyl
		Carbofuran	^{2}Parathion ethyl
		Dematon-O	^{2}Parathion methyl
		Dematon-S	Phorate
		Demeton	Profluralin
		diazinon	Prometon
		Dichlofenthion	Prometryn
		^{2}Dichlorvos	Propachlor
		Dnoseb	Propazine
		Disulfoton	Propham
		Diuron	Propoxur
		Ethalfluralin	Simazine
		^{2}Ethion	Simetryn
		Fensulfothion	Terbacil
		Fenthion	Terbufos
		Fluometuron	Terbuthylazine
		Glyphosate	Terbutryn
			Trifluralin

TABLE XIII-1

MODEL TREATMENT TECHNOLOGY FOR PSES FOR THE PESTICIDE MANUFACTURING SUBCATEGORY (Continued, Page 2 of 2)

1. 24 priority pollutants where PSES = P/C

   a. Five of these pollutants have demonstrated PSES = P/C in pesticide data base
   b. Six of these pollutants were confirmed using technology transfer from pesticide data base.
   c. Thirteen of these confirmed by organic P/C (using technology transfer)

   Two pollutants not confirmed

   2,4 Dinitrophenol: PSES should be P/C + Bio

   Two plants affected:

   1 indirect - meet limit
   1 direct - has Bio, costed P/C originally

   Cyanide:

   Affects 7 directs/4 indirects
   NOA said BAT limit based on P/C + Bio.
   Limit actually based on plants with Bio and P/C + Bio (8 plants).
   The 1 pesticide plant with high CN meets limit with P/C + Bio (proprietary P/C system).

   Two priority pollutant where PSES = No discharge

   ° 1,3 - Dichloropropene
   ° Bis (2-Chloroethyl) ether

2. 7 of the 50 Cat. 1 NCPS discharged by 5 Indirect discharges (Plant Nos. 5, 28, 31, 46, and 182). All the remaining indirect dischargers only discharged Cat. 2 NCPs. For the 5 indirects, 1 plant has bio. (costed P/C only for parathion ethyl & parathion methyl) and 4 plants costed P/C and bio.

TABLE XIII-2

Model Treatment Technology for PSES

Metallo-organic Pesticide Producers

- Cadmium, copper, arsenic
  - Contract haul and Incineration
- Mercury
  - Zinc Precipitation

Pesticide Formulator Packagers

Contract haul and Incineration
Recycle/Reuse

SECTION XIV

DERIVATION OF EFFLUENT LIMITATIONS AND STANDARDS FOR THE ORGANIC PESTICIDE CHEMICALS MANUFACTURING SUBCATEGORY

INTRODUCTION

This section describes the selection of the recommended treatment technologies, the data base and the methodology for determining the effluent limitations and standards for the Organic Pesticide Chemicals Manufacturing Subcategory.

SELECTION OF RECOMMENDED TREATMENT TECHNOLOGIES

In selecting the type of best performance treatment technologies recommended for organic pesticide chemicals manufacturing wastestreams, the Agency evaluated such factors as the technical feasibility of the treatment to remove pollutants of concern, the capital, annual and energy costs of the treatment, the reliability of the technology, the availability of the technology on a full-scale basis, the compatibility of the technology with other treatment units and the versatility of treatment in terms of the types and levels of pollutants which may be treated. A significant important factor in the Agency's selection of treatment technologies was whether or not the technology was being used in the pesticide industry. Table XIV-1 presents seven technologies selected by the Agency as the basis for the effluent limitations guidelines and standards. These technologies are currently operated on a full-scale basis within the pesticide manufacturing industry. Table XIV-1 also shows six technologies that the Agency did not recommend as best performance since their use had not been adequately demonstrated in the pesticide industry.

Selection of the Data Base Used to Develop Limitations and Standards

As discussed previously, based upon the available data for the pesticides industry as set forth in Section VI of this Document, the Agency has selected treatment technologies for each specific pesticide process. Once these technologies were selected, the Agency also evaluated the performance of these technologies on wastewaters in the organic chemicals, plastics and synthetic fibers ("OCPSF") and pharmaceuticals industries for several pollutants.

Specifically, the Agency transferred performance data from steam strippers for methylene chloride from the pharmaceutical industry and performance data from steam strippers for benzene, toluene, chloroform, dichloromethane, carbon tetrachloride and 1-2 dichloroethane from the OCPSF industry. The specific removals of these pollutants by steam stripping in the OCPSF and pharmaceutical industry has been previously discussed in Section VI of the Development Document. The Agency believes that it is reasonable to transfer steam stripping data for these pollutants to the pesticide industry because the raw waste load data into the steam stripper for these pollutants in the pesticide data base is similar or lower than to the raw waste load data into the steam strippers for these pollutants in the OCPSF and pharmaceutical data base. See August 28, 1985 memorandum to the record, Section II.B.1. Moreover, since the pollutants at issue are used as solvents or raw materials in the pharmaceuticals, OCPSF and pesticide industry, the process step for manufacturing these pollutants is similar. (see, for example, The Pesticide Manual, Kirk and Othmer, and the information listed in Section XX-Appendix 6 of this report). Given these two factors, the Agency believes that the removal efficiency of the steam strippers for methylene chloride will be the same in the pesticides and pharmaceuticals industry and for benzene, toluene, chloroform, dichloromethane, carbon tetrachloride and 1,2-dichloroethane will be the same in the OCPSF industry and the pesticides industry.

The Agency assembled the treatment technology performance data from pesticides industry and the OCPSF and pharmaceuticals industry (for the above referenced pollutants) into one data base.

The Agency edited the data base to remove plant data for the following reasons:

1. The Agency edited the data base to remove all data for nonregulated pollutants.

2. Data for which adequate analytical methods did not exist (i.e., those with minimal quality assurance/quality control specifications) were deleted.

3. The Agency deleted effluent data for which we had no corresponding influent level data or the influent data into the biological system was at less than 85 ppb. These data were eliminated because the Agency was unable to assure that the effluent values at the end of the treatment system reflected the actual treatment of pollutants as opposed to low levels of raw waste concentrations which were not

removed by the treatment system. Use of this editing rule is conservative because it avoids the promulgation of effluent limitations guidelines which do not reflect actual treatment.

4. Three data pairs were eliminated because the effluent level was higher than the corresponding influent level.

5. Two data points for nonconventional pollutants were eliminated because they were identified as outliers.

After editing the data base, the Agency evaluated the remaining data base to identify "best performance" treatment systems.

The Agency evaluated each individual treatment system at each plant to identify best performance systems. In order to select best performance plants, the Agency developed performance criteria for each treatment system. The best performance criteria are presented in Table XIV-2. These criteria were based on engineering evaluations of removal efficiencies, detention time, loading rates and other design criteria. The data upon which these performance criteria are based were identified in Section VI of the 1982 Pesticide Development Document. The application of this data to the selection of the best performance criteria is found in Section II.B.1 of the Record. (Refer to December 21, 1984 ESE letter).

Table 1 in the June 13, 1984 NOA sets forth two criteria for selection of best performance treatment data percent removal of the treatment system and treated effluent concentration. The primary criterion evaluated by the Agency was percent removal which best establishes treatment system performance. If a plant did not meet the established percent removal, the plant could still be considered "best performance" if it met the established effluent concentrations.

A treatment system was defined as "best performance" if the system met the treatment performance criteria for any regulated pollutant for which the treatment system was designed. In order to determine for which pollutant a treatment system was designed, the Agency reviewed the raw waste load data at each plant. If a pollutant was demonstrated to be in a significant amount in a plant's raw waste load, the Agency assumed that the treatment system was designed for that pollutant (i.e., steam stripping units were examined for volatile organics, not phenolic pollutants).

The Agency arrayed the data base for each plant by average percent removal for each treatment system. The Agency found large disparities in average removals and effluent concentrations in the arrayed data base. The majority of the plants had removal efficiencies and effluent concentrations clustered around or above the best performance value; the plant or plants whose removal efficiency or effluent concentration was significantly different correlated with the "non best performance" plant in terms of the engineering criteria.

As a result of this best performance analysis, the Agency deleted four treatment systems for nonconventional pollutants and one treatment system for priority pollutants because the system failed the best performance criteria.

For those treatment systems which did not meet the performance criteria, the Agency identified specific reasons why the performance of these systems is inadequate to be considered BAT treatment. Typical examples are that the system is too small for the treated flows or that the carbon usage rate is too low.

Methodology for Determining the Limitations and Standards

In developing effluent limitations and standards the Agency used the data base and model treatment technologies described above. The methodology for developing these limitations and standards is described below. The model treatment technology for BAT and pretreatment for each regulated pollutant is given in Table XI-1 XIII-1. The limitations and standards are given in Table II-1 and II-2. In calculating these limitations and standards the Agency used a delta lognormal statistical distribution. This analysis is described in detail in the record to this rulemaking in "Limitations and Standards Methodology for Pesticide Chemicals Industry," August 30, 1985.

BAT Effluent Limitations Guidelines for Priority Pollutant

To derive BAT effluent limitations, the Agency first evaluated the removal of priority pollutants by plants which have well operated biological treatment units. The Agency used data from best performance biological treatment systems to calculate a long-term average effluent value for each priority pollutant. The long-term average values are estimates of average pollutant levels expected to be found in treated effluent from well-operated biological systems with varying influent priority pollutant levels. These long-term average values are the basis for the BAT effluent limitations guidelines. For most pollutants, data from more than one best performance system for a specific priority pollutant were used to calculate the long-term average. For nine priority pollutants, biological performance data were not available. In these cases the Agency determined in its technology transfer analysis, whether a sufficient basis existed for transferring the biological removals from structurally similar compounds. (The Agency's technology transfer methodology is discussed fully in the record to this regulation and Section V of the preamble to the regulation). In cases where the Agency decided that there was an insufficient basis for transferring biological removal from other compounds, the BAT limitations and standards are based on the performance of physical/chemical treatment only.

The Agency then examined the average influent concentration for each priority pollutant in each of the best performing biological systems to determine the highest average influent concentration associated with an average treated effluent concentration less than or equal to the long term average for the priority pollutant. These influent values are termed "trigger values." The trigger value is the highest influent level treatable with biological treatment alone. If a plant had an influent value higher than the trigger value, then physical/chemical treatment prior to biological treatment is recommended and costed as part of the model treatment technology. The physical/chemical treatment should reduce the priority pollutant below the trigger value. For pollutants for which there were no biological removal data and for which transfer of data was not supportable, the BAT effluent limitation was based on the performance of physical chemical treatment only.

Pretreatment Standards for Priority Pollutants

Pretreatment standards are established to prevent the discharge of any pollutant through publicly owned treatment works (POTWs) which interfers with or passes through the POTW. To identify the pollutants which pass through a POTW the Agency compared the average percent removal of the BAT treatment system to the average percent removal obtained by well operated POTW's achieving secondary treatment. Pollutants for which the POTW removal is lower than the BAT removal pass through the POTW and are designated as incompatable pollutants. In making this comparison, the Agency found that six priority pollutants do not pass through the POTW (five of these are volatile pollutants which may cause subsequent air pollution problems on POTW safety problems).

The pretreatment standards for the 28 priority pollutants which are incompatible with the operation of POTW's are equal to the BAT limitations for these pollutants. The model treatment technology for 26 of these pollutants is physical chemical treatment only. For two pollutants, the model treatment technology is physical/chemical followed by biological treatment.

BAT Limitations for Nonconventional Pesticide Pollutants

The Agency developed limitations for specific nonconventional pesticides by using a two-step process. First, the Agency calculated the long-term average physical/chemical effluent for each pesticide for which it had a valid analytical method. In cases where the Agency did not have appropriate data on a specific pesticide, the Agency determined whether it could transfer data from a similar compound within the same structural group (the structural groups, their basis and the transfer methodology are discussed in the Agency's technology transfer analysis, "Technical Document of Technology Transfer for Nonconventional Pesticides," August 1985). If no data were available and it was not appropriate to transfer data from another compound, the pesticide was not regulated.

The second step in establishing limitations and standards was to determine average percent removal of best performing biological treatment for each pesticide where biological removal data was not available. The Agency determined whether data could be transferred from another pesticide in the same structural group. For pesticides where biological removal data were available or could be transferred, the BAT limitations and standards were determined by multiplying the physical/chemical effluent by the biological percent removal. Where no biological data existed or could be transferred, the BAT limitations and standards were based on the physical/chemical treatment effluent.

Pretreatment Standards for Nonconventional Pesticide Pollutants

The Agency determined that nonconventional pesticide pollutants could interfere with, upset, and pass through POTWs. Accordingly the Agency established pretreatment standards for all the nonconventional pesticides for which BAT limitations were established. The pretreatment standards are equal to the BAT limitations and are based on the same technology.

Confirmatory Data

The Agency used data from the Organic Chemicals Plastics and Synthetic Fibers Industry to confirm the performance of physical/chemical treatment systems which form the basis for pretreatment standards for the priority pollutants. This data was obtained by EPA through a sampling program carried out by the Agency at 12 OCPSF plants. This data (Table XIV-3) shows that physical/chemical treatment (steam stripping) is capable of removing various volatile and semi-volatile organic compounds down to detection limit values. These data were not available until after the June 13, 1984 NOA and were used to confirm the performance levels specified by the methodology set forth above.

Table XIV-1

Treatment Technology Selected as Best Performance*

Treatment Unit	Number of Plants with Treatment	
	BPT	BAT
Biological Oxidation[1]	13	32
Chemical Oxidation[1]	-	9
Granular Activated Carbon[1]	9	17
Hydrolysis[1]	5	8
Metals Separation[1]	-	3
Resin Adsorption[1]	-	4
Steam Stripping[1]	-	8
Ion Exchange[2]	-	-
Membrane Processes[2]	-	-
Powdered Activated Carbon[2]	-	1
Solvent Extraction[2]	-	1
Ultraviolet Photolysis[2]	-	-
Wet Air Oxidation[2]	-	-

Note: 1=Selected as best performance
2=Not selected as best performance
*=Preproposal Data

TABLE XIV-2

Criteria for Best Performance Treatment Technologies[1]

Treatment	CRITERIA Nonconventional Pollutant	Priority or Pollutants
Activated Carbon	≥95% Removal or ≤ 1 mg/l effluent	≥99% Removal or < 1mg/l effluent
Hydrolysis	≥ 95% Removal or ≤ 1 mg/l effluent	
Resin Adsorption	≥ 95% Removal or ≤ 1 mg/l effluent	≥ 99% Removal or ≤ 1 mg/l effluent
Steam Stripping		≥ 90% Removal or ≤5 mg/l effluent
Chemical Oxidation		≥ 99.6% Removal or <0.04 mg/l effuent
Metal Separation		≥ 95% Removal or 0.5 mg/l effluent
Biological Oxidation	≥ 70% Removal ≤ 586 mg/l COD effluent	≥ 95% Removal or ≤ 50 mg/l BOD

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[1] Preproposal Data

Table XIV-3. Physical/Chemical Confirmatory Treatment Data from OCPSF Industry

Volatile Priority Pollutants	Actual Steam Strippers Effluent Concentration (mg/l) Pesticides	OCPSF	Data Trasferred From OCPSF (mg/l)
Benzene	0.1	0.016 (H)	-
Toluene	0.1	-	0.013 (H)
Chlorobenzene	49.0	-	0.013 (H)
1,4 - Dichlorobenzene	-	-	0.013 (H)
Methyl Chloride	-	ND (H)	-
Methyl Bromide	-	-	0.013 (H)
Carbon Tetrachloride	-	-	0.013 (H)
Tetrachloroethylene	-	-	0.013 (H)
Chloroform	13.37	0.010 (H)	-
1,2 - Dichlorobenzene	-	-	0.0125 (M)
1,2,4 - Trichlorobenzene	-	-	0.0125 (M)
Methylene Chloride	6.96	0.010 (M)	-
1,2 - Dichloroethane	-	0.015 (M)	-
1,3 - Dichloropropene	-	-	0.0125 (M)
Bis (2-Chloroethyl) Ether	-	-	1.064 (L)

H: High Strippability Compound
M: Medium Strippability Compound
L: Low Strippability Compound

SECTION XV
DERIVATION OF EFFLUENT LIMITATIONS AND STANDARDS FOR THE METALLO-ORGANIC PESTICIDE MANUFACTURING SUBCATEGORY AND THE FORMULATING/PACKAGING SUBCATEGORY

INTRODUCTION

This section describes the selection of the recommended treatment technologies and the methodology for determining the effluent limitations and standards for the Metallo-organic Pesticide Manufacturing Subcategory and the Pesticide Formulating/Packaging Subcategory.

SELECTION OF RECOMMENDED TREATMENT TECHNOLOGIES

In selecting the type of treatment technologies recommended for metallo-organic pesticide manufacturing and formulating/packaging wastestreams, the Agency evaluated such factors as the technical feasibility of the treatment to remove pollutants of concern, the capital, annual and energy costs to the treatment, the ability of the treatment to perform to levels of concern, the reliability of the technology, the availability of the technology on a full-scale basis, the compatibility of the technology with other treatment units and the versatility of treatment in terms of the types and levels of pollutants which may be treated. The most important factors in the Agency's selection of treatment technologies was whether or not the technology was being used in the pesticide industry. Table XII-2 presents the technologies selected by the Agency as the basis for the effluent limitations guidelines and standards for these two subcategories. These technologies are currently operated on a full-scale basis in the pesticide industry.

Metallo-organic Manufacturers

The Agency is unaware of any existing metallo-organic pesticide manufacturer discharging arsenic, cadmium or copper to a POTW. Therefore, the Agency has not developed plant-by-plant costs for these indirect dischargers. However, PSES are promulgated for these pollutants to control any existing direct discharging facilities which changes to an indirect by discharging these pollutants to a POTW. Since the Agency costed treatment for these facilities under BPT, the costs of installing the recommended treatment technology to achieve zero pollutant discharge have not been calculated by the Agency. Accordingly, PSES for metallo-organic pesticide manufacturers discharging arsenic, cadmium or copper is economically achievable. The recommended zero discharge treatment technologies for manufacturers of arsenic, cadmium or copper metallo-organic pesticides are contract hauling and incineration. These technologies are described in Section VI. Factors associated with the feasibility of implementing these technologies to achieve zero discharge is discussed in this section under formulator/packagers. Only one metallo-organic facility is known to indirectly discharge process wastewater. That facility alleged that it could not achieve zero discharge and recommended that the Agency base PSES for mercury organic pesticides on zinc precipitation. In response to this comment, the Agency, in the June 13, 1984 NOA, announced that it was considering zinc precipitation treatment technology or other similar treatment technology for control of mercury followed by discharge of the treated wastewater as an alternative to the previously proposed zero discharge standards. The Agency requested specific information and data on the wastewater treatment technologies used by this segment of the industry.

The Agency received additional comments from the indirect discharging facility alleging that a zero discharge standard for mercury was neither environmentally sound nor economically achievable. In response to this comment, the Agency sought additional treatment technology and wastewater data from this facility.

As a result of its evaluation of this additional data, the numerical limit for mercury is 0.45 mg/l (daily maximum) and 0.27 mg/l (monthly average) for indirect discharge metallo-organic plants discharging mercury. This pretreatment standard for mercury is based upon the zinc precipitation treatment technology discussed in Section VI. The Agency believes that it is more environmentally sound to require zinc precipitation followed by discharge of the treated wastewater because zero discharge based on incineration or evaporation could produce air pollution associated with the volatilization of mercury. The Clean Water Act requires EPA to consider the non-water quality environmental impacts of the effluent limitations guidelines and standards. Volitilization of mercury in an incinerater could cause violations of the hazardous air pollutant emission standards established under the Clean Air Act for mercury and as such, could create serious non-water quality evironmental impacts. Zero discharge based on recycle/reuse is not technologically achievable for such manufactures. Therefore, the Agency believes that zinc precipitation is an appropriate technology for this process and is preferable to other available treatent methods.

Pesticide Formulator/Packagers

The Agency proposed PSES which would require zero discharge of process wastewater pollutants. The treatment technology bases for pesticide formulating/packaging subcategory were:

1. Contract hauling
2. Spray Evaporation

The Agency believes that the pollutants discharged by formulating/packaging facilities pass through the POTW because the BPT treatment technology achieves no discharge of process wastewater pollutants which is complete removal. Since a POTW cannot achieve this removal for the priority and nonconventional pollutants, the Agency is establishing PSES for these pollutants based on pass through.

Commenters pointed out that evaporation, particularly spray evaporation, can lead to air-pollution and other non-water quality environmental impacts. Commenters also pointed out that contract hauling must be combined with incineration, not land-filling, to be effective in disposing of the pollutants rather than possibly creating future environmental problems. Commenters additionally suggested that treatment technology, such as the physical/chemical treatment technology used by pesticide manufacturers, could achieve low levels of priority pollutants and pesticides in the treated water.

In response to these comments, the Agency revised the technology basis for the promulgated PSES for this subcategory, to combine contract hauling with incineration, to eliminate evaporation, and to add physical/chemical treatment followed by water recycle/reuse. Hence, the technology bases for the promulgated pretreatment standards are:

1. Contact hauling and incineration
2. Physical/chemical treatment with water recycle/reuse and contract hauling followed by incineration for treatment system waste concentrates and any wastewater that cannot be treated and recycled.

Zero discharge of process wastewater pollutants is technologically feasible and economically achievable based on supporting data submitted to the Agency through the random telephone survey, follow-up contacts, and public comments submitted in response to the Federal Register notices. The technological feasibility of the standard is demonstrated by the fact that an estimated 87 percent of the industry currently does not discharge wastewater pollutants.

Plant-by-plant application of the recommended technologies is related to flow and cost. While contract hauling and incineration is less expensive then treatment for low flow plants, treatment and recycle/reuse will be less expensive for high flow plants. The Agency assumes that 96 percent of discharging PFP plants have flows small enough that contract hauling and incineration will be the chosen technology while four percent of the PFP plants with larger flows would choose the treatment and recycle technology.

The Agency believes that incineration will be the treatment technology practiced by contract haulers. The report, "Evaluation of Regulatory Options and the Development of PSES and NSPS compliance costs for the Pesticide Formulating and Packaging Industry," dated August 30, 1985, found that incineration is the favored waste treatment method among pesticide manufacturers. Incineration, under proper operating conditions, can destroy virtually all of the active ingredients of organic pesticides. Therefore, incineration under ideal conditions will result in no solid or liquid discharges. Additionally, for all pollutants except mercury, incineration will not create harmful discharges to the air. For mercury, the Agency believes that incineration of the low concentrations of mercury which are present in formulator/packager wastewaters (as opposed to the high concentrations present in metallo-organic wastewater) will not present an air quality problem. The report concludes that no adverse environmental impacts will be developed by the implementation of incineration technology. The Agency believes that the benefits derived from eliminating the highly toxic wastewater generated will far outweigh any possible risks caused during handling and disposal of pesticide-bearing wastewater. Also, waste must be transported and disposed of under RCRA requirements. Any potential impact associated with the handling of pesticide-bearing wastewaters is believed to be significantly less than associated with the handling of pesticide raw material and products.

Several commenters to the June 13, 1984 NOA stated that there is nothing stopping a contract hauler from discharging waste to a POTW or to navigable waters. However, this regulation covers all wastestreams that contain the regulated pollutants. Contract haulers are subject to the effluent limitations and standards that apply to pesticide manufacturers and formulator/packagers.

They would be direct or indirect discharging facilities and subject to permit requirements.

Information acquired through the 308 questionnaires and follow-up contacts confirm that contract hauling is preferred by formulator/packagers that discharge low volumes of process wastewater. In estimating costs for compliance with PSES, the Agency assumed plants would contract haul and incinerate unless a plant stated it could recycle/reuse the treated wastewater. Based on these statements, the Agency costed contract hauling and incineration for 96 percent of the discharging PFP plants.

For the remaining discharging plants with larger flows, the Agency assumed that physical/chemical treatment followed by recycle/reuse would be the technology chosen. The Agency evaluated treatment and recycle technology for four plants that discharge high volumes of formulating/packaging wastewater. These four plants confirmed that treatment and recycle technology is a feasible means of achieving PSES. The four plants did identify selected production processes that are not amenable to reuse. These processes demand high purity source water to guarantee product integrity. The water volume requirements of these processes is low, therefore wastewater flows which can not be recycled after physical/chemical treatment would be contract hauled and incinerated. One of the four plants presently treats and reuses 75 percent of its treated wastestream as vent scrubber wash water. A second plant incinerates formulating/packaging process waste and discharges incinerator blowdown that contains levels of pesticides measured as not detected. An additional plant, a low flow plant, presently treats its wastewater and discharges no detectable process wastewater pollutants.

The wastewater treatment and recycle scheme confirmed as feasible by the four high flow plants includes the following elements;

1. Formulating/packaging wastestream segregation, collection;
2. Wastewater treatment to include,
    a. Equalization
    b. Steam stripping
    c. Neutralization
    d. Dual media filtration
    e. Carbon adsorption and carbon regeneration
    f. Incineration.
3. Treated wastewater storage and return.

SECTION XVI

ENVIRONMENTAL ASSESSMENT

An assessment of the environmental effects of implementing the recommended standards and limitations is presented in two separate documents prepared during July, 1985 by EPA/Monitoring and Data Support Division: (1) Environmental Assissement of the Direct and Indirect Discharges of Wastewater from the Pesticides Manfacturing Industry; and (2) Environmental Assessment of the Pesticides Formulating/Packaging Industry. These assessments project the significance of post-regulatory discharges of nonconventional pesticides and priority pollutants on human health, aquatic life, and the operation of POTWs.

Impacts are evaluated on receiving streams and on POTW operations. Receiving stream impacts are evaluated at low receiving stream flow using a simplified dilution water quality model which predicits instream pollutant concentrations. Calculations of instream concentrations from indirect dischargers incorporated pollutant removal at POTWs as well as dilution in the collection systems. Impacts were determined by comparing these pollutant concentrations with EPA water quality criteria established for the protection of aquatic life and human health. Not all the pollutants have water quality criteria. For pollutants without criteria, specific toxicity data (i.e., lowest reported LC_{50} values) were used in evaluating impacts. Potential impacts in receiving stream mixing zones were evaluated by comparing undiluted effluent concentrations with acute aquatic life criteria or toxicity values.

Impacts to POTW operations were evaluated in terms of inhibition of POTW processes and contamination of POTW sludges using a simplified POTW model. Inhibition of POTW treatment processes was determined by comparing calculated POTW influent levels available inhibition values. Contamination of sludge was evaluated by comparing projected pollutant concentrations in sludge with available sludge impact values. Contractor-provided data, in the form of recommended effluent standards (expressed as plant-specific concentrations), average daily plant production, total plant discharge flow, and size of the receiving POTW were also used in the model.

The study on pesticide manufacturers evaluated the environmental impacts of 20 priority pollutants and 22 nonconventional pesticide pollutants (NCPs) discharging to waters from 19 pesticide manufacturing plants (12 direct and 7 indirect). These discharges were examined at three technology levels (1) current, (2) proposed BAT/PSES levels, and (3) projected final BAT/PSES.

Under current conditions, ten of the twelve direct facilities and two of the seven indirect facilities would exceed water quality criteria/toxicity values. Implementating the BAT/PSES levels redices the number of plants exceeding criteria and reduces the severity of the exceedances at the remaining plants. The number of pollutants exceeding criteria at current treatment levels is reduced by as much as 50 percent with the implementation of BAT.

There were no exceedances of inhibition vales for POTW operations based on the four of eleven priority pollitants which had inhibition values. Furthermore, the impact on sludge could not be determined since no sludge impact values were available for the pollutants examined.

The study on pesticide formulators/packagers evaluated the environmental impacts of 17 priority pollutants and 11 nonconventional pesticide pollutant (NCP's) discharged to waters from 8 indirect dischargers in the pesticide formulating/packaging industry. These dischargers were examined at two technology levels: (1) current treatment and (2) proposed 30-day average PSES, a considered option. Under current conditions five of the eight facilities would exceed water quality criteria/toxicity values. Implementation of the PSES 30 day option reduced the severity of the exceedances at the remaining plants. The number of pollutants exceeding criteria at current treatment was reduced by as much as 83 percent with the impklementation of the 30 day PSES option.

The recommended option of zero discharge (though not part of the study) would eliminate the limited remaining impacts).

Inhibition of two POTW processes projected at current conditions was reduced to zero at the PSES 30 day option. No impacts on sludge were predicited for the only pollutant with a sludge impact values.

SECTION XVII

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SECTION XVIII

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SECTION XIX

GLOSSARY

Abscission--Process by which a leaf or other part is separated from the plant.

Acaricide (miticide)--An agent that destroys mites and ticks.

Act--The Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500, as amended by the Clean Water Act of 1977, Public Law 95-217.

Activated Carbon--Carbon which is treated by high-temperature heating with steam or carbon dioxide producing an internal porous particle structure.

Activated Sludge--Sludge floc produced in raw or settled wastewater by the growth of zoogleal bacteria and other organisms in the presence of dissolved oxygen and accumulated in sufficient concentration by returning floc previously formed.

Activated Sludge Process--A biological wastewater treatment process in which a mixture of wastewater and activated sludge is agitated and aerated. The activated sludge is subsequently separated from the treated wastewater (mixed liquor) by sedimentation and wasted or returned to the process as needed.

Active Ingredient--The ingredient of a pesticide which is intended to prevent, destroy, repel, or mitigate any pest. The active ingredients may make up only a small percentage of the final product which also consists of binders, fillers, diluents, etc.

Activity Coefficient--An auxiliary thermodynamic function to express the volatile properties of binary systems that exhibit nonideal vapor equilibrium behavior. It may also be regarded as a correction factor that may be applied to ideal conditions to obtain "real" system properties under proper temperature and pressure conditions.

Aerated Lagoon--A natural or artificial wastewater treatment pond in which mechanical or diffused-air aeration is used to supplement the oxygen supply.

Aerobic--Condition in which free molecular oxygen is present.

Aldrin-Toxaphene Pesticide Structural Group--Chlordane, Dienochlor, Endosulfan, Endrin, Heptachlor, Mirex, Toxaphene.
Algicide--Chemical used to control algae and aquatic weeds.

Amide Pesticide Structural Group--Alachlor, Butachlor, Deet, Diphenamid, Fluoroacetamide, Napropamide, Naptalam, Pronamide, Propachlor.

Amide Type Pesticide Structural Group--Aldicarb, Methomyl, Oxamyl, Thiofanox.

Anaerobic--Condition in which free molecular oxygen is absent.

Avicide--Lethal agent used to destroy birds but also refers to materials used for repelling birds.

Attractant, insect--A substance that lures insects to trap or poison-bait stations. Usually classed as food, oviposition, and sex attractants.

Bactericide--Any bacteria-killing chemical.

BAT Effluent Limitations--Limitations for point sources, other than publicly owned treatment works, which are based on the application of the Best Available Technology Economically Achievable. These limitations must be achieved by July 1, 1984.

BCT--Best Conventional Pollutant Control Technology.

Benzidines (Priority Pollutant)--Benzidine, 3,3'-Dichlorobenzidine.

Best Performance Treatment Technologies--Those treatment technologies selected by the Agency and currently inuse in the pesticide industry. They are: biological oxidation, activated carbon, hydrolysis, metals separation, chemical oxidation, resin adsorption, and steam stripping.

Bioconcentration Factor (B.C.F.)--The ratio of the concentration of a chemical in aquatic organisms (ug chemical/g organism) to the amount in water at equilibrium (ug chemical/g water).

Biological Oxidation--Breaking down (oxidizing) organic carbon by bacteria that utilize free dissolved oxygen (aerobic) or "chemically bound" oxygen (anaerobic).

Biological Wastewater Treatment--Forms of wastewater treatment in which bacterial or biochemical action is intensified to stabilize, oxidize, and nitrify the unstable organic matter present. Intermittent sand filters, contact beds, trickling filters, and activated sludge processes are examples.

Blowdown--The removal of a portion of any process flow to maintain the constituents of the flow at desired levels.

BOD--Biochemical oxygen demand is a measure of biological decomposition of organic matter in a water sample. It is determined by measuring the oxygen required by microorganisms to oxidize the organic contaminants of a water sample under standard laboratory conditions. The standard conditions include incubation for five days at 20° C. BOD5--Biochemical oxygen demand, measured after five-day.

Botanical Pesticide--A pesticide produced from naturally occurring chemicals found in some plants. Examples are nicotine, pyrethrum, strychnine, and rotenone.

Botanical Pesticide Structural Group--Allethrin, Permethrin, Pyrethrin, Resmethrin, Rotenone.

BPT Effluent Limitations--Limitations for point sources, other than publicly owned treatment works, which are based on the application of the Best Practicable Control Technology Currently Available. These limitations must be achieved by July 1, 1977.

Btu--British thermal unit.

Bypass--An act of intentional noncompliance during which waste treatment facilities are circumvented in emergency situations.

C--Degrees Centigrade.

Carbamate Pesticide Structural Group--Aminocarb, Barban, Bendiocarb, Benomyl, Carbaryl, Carbendazim, Carbofuran, Chlorpropham, Methiocarb, Mexacarbate, Polyphase antimildew, Propham, Propoxur, Sulfallate, SWEP.

cc--Cubic centimeter.

Cal--Calorie.

Carbamates--A group of insecticides which act on the nervous system by inhibiting the acetylcholinesterase enzyme at the nerve synapse.

Carbon Regeneration--The process of reactivating exhausted or "spent" carbon by thermal means.

Carcinogen--A substance that causes cancer in animal tissue.

Chemical Name--Scientific name of the active ingredient(s) found in the formulated product. The name is derived from the chemical structure of the active ingredient.

Chemical Oxidation--Oxidizing organic carbon by chemical means.

Chemosterilant--Chemical compounds that cause sterilization or prevent effective reproduction.

Chlorinated Ethanes and Ethylenes (Priority Pollutant)--Chloroethane; 1,1-Dichloroethane; 1,2-Dichloroethane; 1,1,1-Trichloroethane; 1,1,2-Trichloroethane; 1,1,2,2-Tetrachloroethane; Hexachloroethane; Vinyl chloride; 1,1-Dichloroethylene; 1,2-Trans-dichloroethylene; Trichloroethylene; Tetrachloroethylene. Chlorinated Aryloxyalkanoic Acids and

Esters Pesticide Structural Group--2,4-D; 2,4-D isobutyl ester; 2,4-D isooctyl ester; 2,4-D salt; 2,4-DB; 2,4-DB isobutyl ester; 2,4-DB isooctyl ester; Dichlorprop; MCPA; MCPA isooctyl ester; MCPP, Silvex; Silvex isooctyl ester; Silvex salt; 2,4,5-T.

Cholinesterase--The enzyme responsible for nervous impulse transmission.

Clarifier--A treatment unit of which the primary purpose is to reduce the amount of suspended matter in a liquid.

Clean Water Act--Enacted in 1977 to amend the Federal Water Pollution Control Act of 1972 and broadens regulations to improve water quality and the control of potentially toxic pollutants.

cm--Centimeter.

COD--Chemical oxygen demand. Its determination provides a measure of the oxygen demand equivalent to that portion of matter in a sample which is susceptible to oxidation by a strong chemical oxidant.

Combined Wastewater--Wastewater from a number of pesticide, pesticide intermediate, and non-pesticide processes.

Common Pesticide Name--A common chemical name given to a pesticide by a recognized committee on pesticide nomenclature. Many pesticides are known by a number of trade or brand names but have only one recognized common name. For example, the common name for Sevin insecticide is carbaryl.

Contract Hauling--Disposal of waste products through an outside party for a fee.

Conventional Pollutants--For the Pesticide Industry conventional pollutants are defined as BOD, TSS, and pH.

cu ft--Cubic feet.

Cyanate Pesticide Structural Group--Methylene bisthiocyanate; Nabonate; TCMTB.

Cyanides (Priority Pollutant)--Cyanide.

Cyclodienes--A group of insecticides which are structurally characterized as chlorinated cyclic hydrocarbons.

DDT Type Pesticide Structural Group--Chlorobenzilate; DDD; DDE; DDT; Dicofol; Methoxychlor; Perthane. Deep Well Injection--Disposal of wastewater into a deep-well such that a porous, permeable formation of a large area and thickness is available at sufficient depth to ensure continued, permanent storage.

Defoliant--A chemical that initiates abscission.

Desiccant--A chemical that induces rapid dehydration of a leaf or plant part.

Design Effluent Level--Long-term average effluent levels demonstrated or judged achievable for recommended treatment technologies presented in Section VI, from maximum raw waste load levels presented in Section V.

Dichloropropane and Dichloropropene (Priority Pollutant)-1,2-Dichloropropane; 1,2-Dichloropropylene.

Dienes (Priority Pollutant)--Hexachlorobutadiene; Hexachlorocyclopentadiene.

Dioxin Type Pesticide Structural Group--Dimethoxane.

Direct Discharge--Discharge of wastewater into navigable waters.

Disinfectant--A substance used for the art of killing the larger portion of microorganisms in or on a substance with the probability that all pathogenic bacteria are killed by the agent used.

Dual Media Filtration--The process of separation suspended solids from wastewater; dual media filtration contains sand, anthracite, or garmet for the removal of suspended solids.

Dual Significance--Classification of priority pollutants which are: (1) manufactured pesticide products (primary significance) and are controlled by monitoring other pollutants of primary significance (secondary significance), or (2) manufactured pesticide products with zero wastewater discharge (primary significance) and lack adequate monitoring data to recommend regulation in other pesticide processes (secondary significance).

e--The base for the natural or Naperian logarithms which equals 2.71828...

EMSL--Environmental Monitoring and Support Laboratory.

Evaporation Pond--An open holding facility which depends primarily on climatic conditions such as evaporation, precipitation, temperature, humidity, and wind velocity to effect dissipation (evaporation) of wastewater. External means such as spray recirculation or heating can be used to increase the rate of evaporation.

Excursion--An excursion, sometimes called an upset, is unintentional noncompliance occurring for reasons beyond the reasonable control of the permittee. F--Degrees Fahrenheit.

Equalization--A treatment unit consisting of a wastewater holding vessel that functions to equalize wastewaters and provide a constant discharge rate and wastewater quality.

FIFRA--The Federal Insecticide, Fungicide and Rodenticide Act of 1947.

Flocculation--The agglomeration of colloidal and finely divided suspended matter.

Flotation--The raising of suspended matter to the surface of the liquid in a tank as scum--by aeration, the evolution of gas, chemicals, electrolysis, heat, or bacterial decomposition--and the subsequent removal of the scum by skimming.

F:M ratio--The ratio of organic material (food) to mixed liquid (microorganisms) in an aerated sludge aeration basin.

Formulation/packaging of Pesticides--The physical mixing of technical grade pesticide ingredients into liquids, dusts and powders, or granules, and their subsequent packaging in a marketable container.

fpm--Feet per minute.

fps--Feet per second.

ft--Feet.

Fumigant--A volatile material that forms vapors that destroy insects, pathogens, and other pests.

Fungicide--A chemical that kills fungi.

Gal--Gallons.

Gal/1,000 lbs--Gallons of wastewater flow per 1,000 pounds of pesticide production.

GC--Gas chromatograph.

GC/MS--Gas chromatography/mass spectrometry.

Genome--A haploid set of chromosomes, or of chromosomal genes, inherited as a unit from one parent.

Girdling--Removal of bark and cambium layer around a plant stem in the form of a ring.

Goitrogenic--Tending to produce goiters (an enlargement of the thyroid gland visible as a swelling of the front of the neck).

gpd--Gallons per day.

gpm--Gallons per minute. Growth Regulator--Organic substance effective in minute amounts for controlling or modifying (plant or insect) growth processes.

Haloethers (Priority Pollutant)--Bis(chloromethyl)ether; Bis(2-

chloroethyl)ether; 2-chloroethyl vinyl ether; Bis(2-chloroisopropyl)ether; Bis(2-chloroethoxy)methane; 4-chlorophenyl phenyl ether; 4-Bromophenyl phenyl ether.

Halogenated Aliphatic Pesticide Structural Group--BHC; Chloropicrin; Dalapon; DBCP; D-D; Dichloroethyl ether; Dichloropropene; Ethylene dibromide; Lindane; Methyl bromide.

Halogenated Aromatic Pesticide Structural Group--Bifenox; Bromoxynil; Bromoxynil octanoate; Captafol; Chloramben; Chlorobenzene; Chlorophacinone; Chlorothalonil; Coumachlor; DCPA; Dicamba; Dichlorobenzene, ortho; Dichlorobenzene, para; Dichlorophen; Dichlorophen salt; Hexachlorophene; Nitrofen; PCNB; PCP; PCP salt; Piperalin; Propanil; Trichlorobenzene.

Halomethanes (Priority Pollutant)--Methyl chloride; Methyl bromide; Methylene chloride; Chloroform; Bromoform; Dichlorobromomethane; Chlorodibromomethane; Carbon tetrachloride; Trichlorofluoromethane; Dichlorodifluoromethane.

Hepatocellular Carcinomas--Malignant tumors of the cells comprising the outer layer of the liver.

Hepatoma--Malignant tumor of the liver proper.

Herbicide--Chemical substance used to destroy undesirable plant life such as weeds.

Heterocyclic With Nitrogen in the Ring Pesticide Structural Group-BBTAC; Bentazon; Captan; Cycloheximide; Dowicil 75; Ethoxyquin 66%; Ethoxyquin 86%; Fenarimol; Folpet; Glyodin; Maleic Hydrazide; MGK 264; MGK 326; Molinate; Norflurazon; Paraquat; Picloram; 8 Quinolinol citrate; 8 Quinolinol sulphate; Quinomethionate.

hp--Horsepower.

hr--Hour.

Hydrolysis--The degradation of pesticide active ingredients, most commonly through the application of heat at either acid or alkaline conditions.

in--Inch.

Incineration--The combustion (by burning) of organic matter in vapor and/or aqueous streams. Inorganic Pesticide--Pesticides that do not contain carbon.

Insect-Growth Regulator (IGR)--Chemical substance that disrupts the action of insect hormones controlling molting, maturity from pupal stage to adult, and others.

Insecticide--Chemical substance used to control insects.

Intraperitoneal--Within the smooth transparent serous membrane that lines the cavity of the abdomen of mammals.

kg--Kilogram.

kkg--1,000 kilograms.

kPa--Kilopascal-SI unit of pressure equal to 0.01 bars or 0.75 millimeters of mercury.

kw--Kilowatt.

L(l)--Liter.

Lagoon--A pond containing raw or partially treated wastewater in which aerobic or anaerobic stabilization occurs.

Land Disposal--Disposal of wastewater onto land.

lb--Pound.

lbs/1,000 lbs--The mass of a particular pollutant (in pounds) per 1,000 pounds of pesticide production.

LC50--Lethal concentration 50; the concentration of a toxic material at which 50 percent of the test organisms die when exposed to the toxic material by a route other than respiration, i.e., orally or dermally, expressed in mg (toxic material)/kg (body weight).

LD50--Lethal dose 50; the dose of a toxic material at which 50 percent of the test organisms die when exposed to the toxic material by a route other than respiration, i.e., orally or dermally, expressed in mg (toxic material)/kg (body weight).

Long-Term Average--The average (mg/l or lbs/1,000 lbs) effluent for a pollutant at a particular point in the wastewater treatment system, based on available data. Treatment variability factors may be multiplied by the long-term average to derive 30-day maximum and daily maximum effluent limitations.

Level of Interest--The detection limit as an analytical goal for this project, as follows: Organic pollutants = 0.01 mg/l; Pesticides

= 0.001 mg/l; Metals (mg/l)

Zn = 1.0
Sb = 0.1
As = 0.025
Be = 0.05
Cd = 0.005
Cr = 0.025
Cu = 0.02

Pb = 0.025
Hg = 0.001
Ni = 0.5
Se = 0.01
Ag = 0.005
Tl = 0.05

m--Meter.

Manufacturer of Pesticide Active Ingredients--The chemical and/or physical conversion of raw materials to technical grade ingredients intended to prevent, destroy, repel, or mitigate any pest. For purposes of this study only the final synthesis step is included.

Manufacturer of Pesticide Intermediates--The manufacture of materials resulting from each reaction step in the creation of pesticide active ingredients, except for the final synthesis step. According to this definition an excess of materials need not be produced.

Manufacturer of Products Other Than Pesticides--The manufacture of products not specifically defined in the scope of coverage (e.g., organic chemicals, plastics and synthetics, pharmaceuticals, etc.).

Membrane Processes--Such as reverse osmosis, and ultrafiltration are used primarily in the metal industry to remove solutes from wastewater.

Mercaptan--Various compounds with the general formula R-SH that are analogous to the alcohols and phenols but contain sulphur in place of oxygen and often have disagreeable odors.

Metallo-Organic Pesticides--A class of organic pesticides containing one or more metal or metalloid atoms in the structure.

Metallo-Organic Pesticide Structural Group--Cyhexatin; Fentin hydroxide; Ferbam; Mancozeb; Maneb; Niacide; Tributyltin benzoate; Tributyltin fluoride; Tributyltin oxide; Vancide 512; Vancide 512 dispersion; ZAC; Zineb; Ziram.

Metals (Priority Pollutant)--Antimony, Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Silver, Thallium, Zinc.

Metals Separation--Metallic ion removal from wastewater by conversion to an insoluble form using such agents as lime, soda ash, or caustic followed by a separation process, usually clarification or filtration.

mg--Milligram.

MG--Million gallons.

MGD--Million gallons per day. mg/l--Milligrams per liter (equal parts per million, ppm, when the specific gravity is one).

Microbial--Of or pertaining to a pathogenic bacterium.

min--Minute.

Miscellaneous Priority Pollutants--Acrolein, Acrylonitrile, Asbestos, Isophorone, 1,2-Diphenylhydrazine.

Miticide--Chemical substance used to destroy mites, acaricides.

ml/l--Milliliters per liter.

MLSS--Mixed-liquor suspended solids.

MLVSS--Mixed-liquor volatile suspended solids.

mm--Millimeter.

Moiety--A chemical functional group.

Molluscicide--A chemical used to kill or control snails and slugs.

Mutagen--Substance causing genes in an organism to mutate or change.

NACA--National Agricultural Chemicals Association.

Navigable Waters--Includes all navigable waters of the United States; tributaries of navigable waters; interstate waters; intrastate lakes; rivers and streams which are utilized by interstate travelers for recreational or other purposes; intrastate lakes, rivers and streams from which fish or shellfish are taken and sold in interstate commerce; and intrastate lakes, rivers and streams which are used for industrial purposes by industries in interstate commerce.

Nematicide--A chemical used to kill nematodes.

Neutralization--The process of neutralizing wastewater using alkaline or acidic agents.

Nitro Pesticide Structural Group--Benfluralin, CDN, DCNA, Dinocap, Dinoseb, Ethalfluralin, Fluchloralin, Giv-Gard, Isopropalin, Metasol J-26, Oryzalin, Profluralin, Trifluralin.

Nitrosamines (Priority Pollutant)--N-nitrosodimethylamine, N-nitrosodi-n-propylamine, N-nitrosodiphenylamine.

Nitrosubstituted Aromatics (Priority Pollutant)--Nitrobenzene; 2,4-Dinitrotoluene; 2,6-Dinitrotoluene.

Noncategorized Pesticides Structural Group--Benzyl benzoate, Benzyl bromoacetate, Busan 90, Cycloprate, Fluoridone, HAE, HAMP, Kinoprene, Methoprene, NMI, Oxyfluorfen, Piperonyl butoxide, Sodium monofluoroacetate, Warfarin.

Noncontact Wastewater--Wastewater which is not contaminated by the process or related materials. Examples include boiler blowdown, cooling water, sanitary sewage. Storm water from outside the immediate manufacturing area may be included in this definition if it is not contaminated from product spills, etc.

Nonconventional Pollutants--For the Pesticide Industry nonconventional pollutants are defined as nonpriority pollutant pesticides, COD, ammonia, and manganese (see Table X-1).

Nonhalogenated Aliphatic Pesticide Structural Group--Propionic acid.

Nonhalogenated Aromatic Pesticide Structural Group--Biphenyl, Coumafuryl, Coumatetralyl, Diphacinone, Phenylphenol, Phenylphenol sodium salt, Pindone.

Nonhalogenated Cyclic Aliphatic Pesticide Structural Group--Endothall.

Non-Pass Through Pollutants--Those pollutants that are biodegradable, and do not pass through biogical oxidation treatment systems.

NPDES--National Pollution Discharge Elimination System. A federal program requiring industry to obtain permits to discharge plant effluents to the nation's water courses.

NSPS--New Source Performance Standards.

Nutrients--The nutrients in contaminated water are routinely analyzed to characterize the food available for microorganisms to promote organic decomposition. They are: Ammonia Nitrogen (NH_3), mg/l as N; Kjeldahl Nitrogen (TKN), mg/l as N; Nitrate Nitrogen (NO_3), mg/l as N; Total Phosphate (TP), mg/l as P; Ortho Phosphate (OP), mg/l as P.

Ocean Discharge--Discharge of wastewater into an ocean.

Oncogenic--The property to produce tumors (not necessarily cancerous) in tissues (see Carcinogen).

Opacity--The ratio of transmitted to incident light.

Organo-Nitrogen Others Pesticide Structural Group--Alkylamine hydrochloride, Benzethonium chloride, Dazomet, Diphenylamine, Dodine, Etridiazole, Hyamine 2389, Hyamine 3500, Kathon 886, Lethane 384, Metasol DGH, Methyl benzethonium chloride, Octhilinone, PBED, Thiabendazole, Triadimefon, Tricyclazole.

Organo--Phosphorus Pesticide Structural Group--Dyfonate, phorate, naled, diazinon, malathion.

Organo-Sulfur Pesticide Structural Group--EXD, HPTMS, Propargite, Sulfoxide, Vancide PA.

Ovicide--A chemical that destroys an organism's eggs.

Pass-Through Pollutants--Those pollutants that are not readily biodegradable and pass through biological oxidation treatment systems.

Patent--An official document issued by the U.S. Office of Patents conferring an exclusive right or privilege to produce, use, or sell a pesticide for a specified period of time. Pathogen--Any disease-producing organism or virus.

PCB--Polychlorinated biphenyl.

Pesticide--Any technical grade ingredient used for controlling, preventing, destroying, repelling, or mitigating any pest. See Section III for classes of pesticides covered; see Section XVIII-Appendix 3 for individual pesticides covered.

Pesticide (Priority Pollutant)--Aldrin; Dieldrin; Chlordane; 4,4'-DDT; 4,4'-DDE; 4,4'-DDD; a-endosulfan-Alpha; b-endosulfan-Beta; endosulfan sulfate; endrin; endrin aldehyde; heptachlor; heptachlor epoxide; a-BHC-Alpha; b-BHC-Beta; r-BHC-Gamma; g-BHC-Delta; Toxaphene.

pH--pH is a measure of the acidity or alkalinity of a water sample. It is equal to the negative log of the hydrogen ion concentration.

Phenols (Priority Pollutant)--Phenol; 2-Chlorophenol; 2,4-Dichlorophenol; 2,4,6-Trichlorophenol; Pentachlorophenol; 2-Nitrophenol; 4-Nitrophenol; 2,4-Dinitrophenol; Parachlorometa cresol; 4,6-Dinitro-o-cresol; 2,4-Dimethylphenol.

Pheromones--Highly potent insect sex attractants produced by the insects. For some species, laboratory-synthesized pheromones have been developed for trapping purposes.

Phosphate and Phosphonate Pesticide Structural Group--Dichlorvos, Mevinphos, Monocrotophos, Naled, Stirofos.

Phosphorothioate and Phosphorodithioate Pesticide Structural Group-Aspon, Azinphos methyl, Bolstar, Carbophenothion, Chlorpyrifos, Chlorpyrifos methyl, Coumaphos, Cythioate, Demeton, Demeton-o, Demeton-s, Diazinon, Dichlofenthion, Dioxathion, Disulfoton, EPN, Ethion, Ethoprop, Famphur, Fenitrothion, Fensulfothion, Fenthion, Fonofos, Malathion, Merphos, Oxydemeton, Parathion ethyl, Parathion methyl, Phorate, Phosmet, Ronnel, Temephos, Terbufos, Thionazin, Trichloronate, Tokuthion.

Phosphorus-Nitrogen Pesticide Structural Group--Acephate, Bensulide, Glyphosate, Mephosfolon, Methamidophos, Phosfolan.

Phthalate Esters (Priority Pollutant)--Bis(2-ethylhexyl)phthalate; Butyl benzyl phthalate; Di-n-butyl phthalate; Di-n-octyl phthalate; Diethyl phthalate; Dimethyl phthalate.

Phytotoxic--Poisonous to plants.

Piscicide--Chemical used to kill fish.

Polychlorinated Biphenyl's (Priority Pollutant)--PCB-1242; PCB-1254; PCB-1221; PCB-1232; PCB-1248; PCB-1260; PCB-1016. Polynuclear Aromatic Hydrocarbons (Priority Pollutant)--Benzo(a)anthracene; Benzo(a)pyrene; 3,4-Benzofluoranthene; Benzo(k)fluoranthene; Chrysene; Acenaphthylene; Anthracene; Benzo(ghi)perylene; Fluorene; Phenathrene; Dibenzo(a,h)anthracene; Indeno(1,2,3-cd) pyrene; Fluoranthene; Naphthalene; 2-Chloronaphthalene; Acenaphthene.

Polyploidy--Exhibiting entire extra sets of chromosomes with three or more genomes.

Postemergence--After emergence of the specified weed or crop.

POTW--Publicly owned treatment works.

ppb--Parts per billion (equal micrograms per liter, ug/l, when the specific gravity is one).

ppm--Parts per million (equal milligrams per liter, mg/l, when the specific gravity is one).

ppt--Parts per trillion (equal nanograms per liter, ng/l, when specific gravity is one).

Pre-emergence--Refers to the time before sprouting from the soil of a specific weed or crop.

Primary Significance--Pollutants are of primary significance if they are recommended for regulation due to their deleterious effects on humans and the environment.

Primary Treatment--The first major treatment in a wastewater treatment works. In the classical sense, it normally consists of clarification. As used in this document, it generally refers to treatment steps preceding biological treatment.

Priority Pollutant--Those compounds specified as an outgrowth of the 1976 Consent Decree as listed in Section XVIII--Appendix 1.

Process Wastewater--Any aqueous discharge which results from or has had contact with the manufacturing process. For purposes of this study only wastewater from the final synthesis step in the manufacture of pesticide active ingredients is included, in addition to the following: (1) Wastewater from vessel-floor washing in the immediate manufacturing area; (2) Stormwater runoff from the immediate manufacturing area; (3) Wastewater from air pollution scrubbers utilized in the manufacturing process or in the immediate manufacturing area.

PSES-Pretreatment Standards for Existing Sources.

psi--Pound per square inch.

PSNS-Pretreatment Standards for New Sources.

QA/QC--Quality Assurance/Quality Control. Quaternary Ammonium Salt--Chemical compound having a chlorine or bromine ion attached to a nitrogen atom with four carbon-nitrogen bonds. May be used as algicides, bactericides, piscicides, etc.

Raw Waste Load--The quantity of flow or pollutant in wastewater prior to a treatment process.

Repellent (insects)--Substance used to repel ticks, chiggers, gnats, flies, mosquitoes, and fleas.

Resin Adsorption--A method of treating wastewater in which a resin material removes organic matter by adherence on the surface of solid bodies.

Risk Level--The population size on which it is estimated that one additional case of cancer will be reported due to the daily consumption of water and edible aquatic organisms.

Rodenticide--Pesticide applied as a bait, dust, or fumigant to destroy or repel rodents and other animals, such as moles and rabbits.

rpm--Revolution per minute.

Sanitary Wastewater--Wastewater discharging from sanitary conveniences such as toilets, showers, and sinks.

Sec--Second.

Secondary Significance--Pollutants are of secondary significance if they are not recommended for regulation, but are specified to be considered on a case-by-case basis for potential deleterious effects on humans and the environment.

Secondary Treatment--The second major step in a waste treatment system. As used in this document, the term refers to biological treatment.

Segregated Wastewater Stream--A wastewater stream generated from part or all of one pesticide process.

Slimicide--Chemical used to prevent slimy growth, as in wood-pulping processes for manufacture of paper and paperboard.

Sludge--The accumulated solids separated from liquids, such as water or wastewater, during processing.

Spray Evaporation--A method of wastewater disposal in which the water in a holding lagoon equipped with spray nozzles is sprayed into the air to expedite evaporation.

Sq. ft.--Square foot. Steam Stripping--An operation in which relatively volatile components are transferred from a liquid mixture to the gas phase by passage of steam through the liquid.

Air/Steam Stripping--A treatment unit process used for separating volatile organics from water and wastewater.

Synergism--Increased activity resulting from the effect of one chemical to another.

Systemic--Compound that is absorbed and translocated throughout the plant or animal.

TCDD (Priority Pollutant--TCDD(2,3,7,8-tetrachlorodibenzo-p-dioxin).

TDS--Total dissolved solids.

Teratogenic--Substance that causes physical birth defects in the offspring following exposure of the pregnant female.

Tertiary Treatment--The third major step in a wastewater treatment process. As used in this document, the term refers to treatment processes following biological treatment.

Thiocarbamate Pesticide Structural Group--Amobam, AOP, Aquatreat DNM 30, Busan 40, Busan 85, Butylate, Carbam S, Cycloate, EPTC, KN Methyl, Metham, Nabam, Pebulate, Vernolate.

TKN--Total Kjeldahl nitrogen.

TLM--Median tolerance limit; the concentration in the environment of a toxic substance at which only 50 percent of the test organisms survive.

TOC--Total organic carbon is a measure of the organic contamination of a water sample. It has an empirical relationship with the biochemical and chemical oxygen demands.

TOD--Total oxygen demand.

Toxic--Poisonous to living organisms.

Treatment Technology--Any pretreatment or end-of-line treatment unit which is utilized in conjunction with process wastewater. The unit may be employed at any point from the process wastewater source to final discharge from plant property.

Triazine Pesticide Structural Group--Ametryne, Anilazine, Atrazine, Cyanazine, Hexazinone, Metribuzin, Prometon, Prometryn, Propazine, Simazine, Simetryne, Terbuthylazine, Terbutryn, Vancide TH.

TSS--Total suspended solids.

ug--Microgram.

Upset--An upset, sometimes called an excursion, is unintentional noncompliance occurring for reasons beyond the reasonable control of the permittee.

Uracil Pesticide Structural Group--Bromacil, Terbacil.

Urea Pesticide Structural Group--Diuron, Fenuron, Fenuron-TCA, Fluometuron, Linuron, Monuron, Monuron-TCA, Neburon, RH 787, Siduron, Tebuthiuron.

Volatile Aromatics (Priority Pollutant)--Benzene; Toluene; Ethyl benzene; Chlorobenzene; 1,2-Dichlorobenzene; 1,3-Dichlorobenzene; 1,4-Dichlorobenzene, 1,2,4-Trichlorobenzene; Hexachlorobenzene.

VSS--Volatile suspended solids.

Wastewater--See process wastewaters.

Wet Air Oxidation-Is a liquid phase oxidation process that destroys pollutants by oxidizing them totally.

Wet Scrubber--An air pollution control device which involves the wetting of particles in an air stream and the impingement of wet or dry particles on collecting surfaces, followed by flushing.

Zero Discharge--The prevention of process wastewater from point sources entering navigable waters either directly or indirectly through publicly owned treatment works.

SECTION XX--APPENDIX 1

PRIORITY POLLUTANTS BY GROUP

Benzidines

1. Benzidine
2. 3,3'-Dichlorobenzidine

Chlorinated Ethanes and Ethylenes

3. Chloroethane
4. 1,1-Dichloroethane
5. 1,2-Dichloroethane
6. 1,1-Dichloroethylene
7. Hexachloroethane
8. 1,1,2,2-Tetrachloroethane
9. Tetrachloroethylene
10. 1,2-Trans-dichloroethylene
11. 1,1,1-Trichloroethane
12. 1,1,2-Trichloroethane
13. Trichloroethylene
14. Vinyl chloride
    (Chloroethylene)

Cyanides

15. Cyanide

Dichloropropane and Dichloropropene

16. 1,2-Dichloropropane
17. 1,3-Dichloropropene

Dienes

18. Hexachlorobutadiene
19. Hexachlorocyclopentadiene

Haloethers

20. Bis(2-chloroethoxy) methane
21. Bis(2-chloroethyl) ether
22. Bis(2-chloroisopropyl) ether
23. Bis(chloromethyl) ether*
24. 4-Bromophenyl phenyl ether
25. 2-Chloroethyl vinyl ether
26. 4-Chlorophenyl phenyl ether

Halomethanes

27. Bromoform
    (Tribromomethane)
28. Carbon tetrachloride
    (Tetrachloromethane)
29. Chlorodibromomethane
30. Chloroform
    (Trichloromethane)
31. Dichlorobromomethane
32. Dichlorodifluromethane*
33. Methyl bromide
    (Bromomethane)
34. Methyl chloride
    (chloromethane)
35. Methylene chloride
    (Dichloromethane)
36. Trichlorofluoromethane*

Metals

37. Antimony
38. Arsenic
39. Beryllium
40. Cadmium
41. Chromium
42. Copper
43. Lead
44. Mercury
45. Nickel
46. Selenium
47. Silver
48. Thallium
49. Zinc

Miscellaneous Priority Pollutants

50. Acrolein
51. Acrylonitrile
52. Asbestos
53. 1,2-Diphenylhydrazine
54. Isophorone

Nitrosamines

55. N-nitrosodimethylamine
56. N-nitrosodiphenylamine
57. N-nitrosodi-n-propylamine

SECTION XX--APPENDIX 1

PRIORITY POLLUTANTS BY GROUP

(Continued, Page 2 of 3)

Nitrosubstituted Aromatics

58. 2,4-Dinitrotoluene
59. 2,6-Dinitrotoluene
60. Nitrobenzene

Pesticides

61. Aldrin
62. a-BHC-Alpha
63. b-BHC-Beta
64. r-BHC-Gamma (Lindane)
65. d-BHC-Delta
66. Chlordane
67. Dieldrin
68. 4,4'-DDD (p-p'-TDE)
69. 4,4'-DDE (p-p'-DDX)
70. 4,4'-DDT
71. a-Endosulfan-Alpha
72. b-Endosulfan-Beta
73. Endosulfan sulfate
74. Endrin
75. Endrin aldehyde
76. Heptachlor
77. Heptachlor epoxide
78. Toxaphene

Phenols

79. 2-Chlorophenol
80. 2,4-Dichlorophenol
81. 2,4-Dimethylphenol
82. 4,6-Dinitro-o-cresol
83. 2,4-Dinitrophenol
84. 2-Nitrophenol
85. 4-Nitrophenol
86. Parachlorophenol
87. Pentachlorophenol
88. Phenol
89. 2,4,6-Trichlorophenol

Polychlorinated Biphenyls

96. PCB-1242 (Arochlor 1242)
97. PCB-1254 (Arochlor 1254)
98. PCB-1221 (Arochlor 1221)
100. PCB-1232 (Arochlor 1232)
101. PCB-1260 (Arochlor 1260)
102. PCB-1016 (Arochlor 1016)

Polynuclear Aromatic Hydrocarbons

103. Acnaphthylene
104. Acenaphthene
105. Anthracene
106. Benzo(A)anthracene (1,2-Benzanthracene)
107. Benzo(a)pyrene (3,4-Benzopyrene)
108. 3,4-Benzofluoranthene
109. Benzo(k)fluoranthene (1,12-Benzoperylene)
110. Benzo(k)fluoranthene (11,12-Benzoperylene)
111. 2-Chloronaphthalene
112. Chrysene
113. Dibenzo(a,h)anthracene (1,2,5,6-Dibenzanthracene)
114. Fluoranthene
115. Fluorene
116. Indeno(1,2,3-cd)pyrene (2,3-o-Phenylenepyrene)
117. Napthalene
118. Phenanthrene
119. Pyrene

TCDD

120. TCDD (2,3,7,8-Tetrachloro-dibenzo-p-dioxin)

SECTION XX—APPENDIX 1

PRIORITY POLLUTANTS BY GROUP

(Continued, Page 3 of 3)

Phthalate Esters

90. Bis(2-ethylhexyl) phthalate
91. Butyl benzyl phthalate
92. Diethyl phthalate
93. Dimethyl phthalate
94. Di-n-butyl phthalate
95. Di-n-octyl phthalate

Volatile Aromatics

121. Benzene
122. Chlorobenzene
123. 1,2-Dichlorobenzene
124. 1,3-Dichlorobenzene
125. 1,4-Dichlorobenzene
126. Ethylbenzene
127. Hexachlorobenzene
128. 1,2,4-Trichlorobenzene
129. Toluene

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* Classification as a priority pollutant discontinued by EPA.

SECTION XX--APPENDIX 2

LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
1.	Acephate (Orthene)	O,S-Dimethyl acetylphosphoramidothioate
2.	Alachlor (Lasso)	2-Chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide
3.	Aldicarb (Temik)	2-Methyl-2-(methylthio)-propionaldehyde-o-(methylcarbomoyl) oxime
4.	Alkylamine hydrochloride	Alkylamine hydrochloride
5.	Allethrin	2-methyl-4-oxo-3-(2-propenyl)-2-cyclopenten-1-yl 2,2-dimethyl-3-(2-methyl-1-propenyl) cyclopropane carboxylate
6.	Ametryne (Evik)	2-Ethylamino-4-isopropylamino-6-methylthio-1,3,5-triazine
7.	Aminocarb	4-Dimethylamino-3-methyl-phenyl methyl-carbamate
8.	Amobam	Diammonium ethylenebisdithiocarbamate
9.	Anilazine (Dyrene)	2,4-Dichloro-6-(2-chloroanilino)-1,3,5-triazine
10.	[AOP] (Ambam oxidation product)	Ethylene bis (dithiocarbamic acid) bimolecular and trimolecular cyclic anhydrosulfides and disulfides

SECTION XX--APPENDIX 2

LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
11.	(Aquatreat DNM 30)	15% Sodium dimethyl dithiocarbamate 15.0% Disodium ethylene bisdithiocarbamate
12.	(Aspon)	tetra-n-Propyl dithiopyrophosphate
13.	Atrazine (Aatrex)	2-Chloro-4-ethylamino-6-isopropylamino-1,3,5-triazine
14.	Azinphos methyl (Guthion)	0,0-Diethyl S-[4-oxo-1,2,3-benzotriazin-3(4H)-ylmethyl] phosphorodithioate
15.	Barban (Carbyne)	4-Chlorobut-2-butynyl-m-chlorocarbanilate
16.	1,1'-(2-butenylene)bis (3,5,7-triaza-1-azo (niaadiamantane chloride) [BBTAC]	1,1'-(2-Butenylene)bis(3,5,7-triaza-1-azo niaadamantane chloride)
17.	Bendiocarb (Ficam)	2,3-Isopropylidenedioxyphenyl methylcarbamate
18.	Benfluralin (Benefin)	N-Butyl-N-ethyl-2,6-dinitro-4-trifluoro-methylaniline
19.	Benomyl (Benlate)	Methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate
20.	Bensulide (Prefar)	S-(0,0-Diisopropyl phosphorodithioate) ester of N-(2-mercaptoethyl)benzene sulfonamide
21.	Bentazon (Basagran)	3-Isopropyl-1H-2,1,3-benzothiadiazion-(4) 3H-one 2, 2-dioxide

SECTION XX--APPENDIX 2

LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
22.	Benzethonium chloride (Hyamine 1622)	Benzyldimethyl[2-<2-(p-1,1,3,3-tetramethylbutylphenoxy)ethoxy>ethyl]ammonium chloride
23.	Benzyl benzoate	Benzylbenzenecarboxylate
24.	Benzyl bromoacetate (Merbac 35)	Benzyl bromoacetate
25.	BHC (Alpha, Beta, and Delta Isomers)*	1,2,3,4,5,6-Hexachlorocyclohexane mixed ixomers
26.	Bifenox (Modown)	Methyl 5-(2,4-dichlorophenyl) 2-nitrobenzoate
27.	Biphenyl (Diphenyl)	Diphenyl
28.	(Bolstar) Sulprofos	O-Ethyl O-[4(methylthio)phenyl]-s-propyl phosphorodithioate
29.	Bromacil (Hyvar)	5-Bromo-3-sec-butyl-6-methyluracil
30.	Bromoxynil (Brominal)	3,5-Dibromo-4-hyroxybenzonitrile
31.	Bromoxynil octanotate	2,6-Dibromo-4-cyanophenyl octanoate
32.	(Busan 40)	Potassium N-hydroxymethyl-N-Methyldithio carbamate
33.	(Busan 85)	Potassium dimethyldithio carbamate
34.	(Busan 90)	2-Bromo-4^1-hydroxyacetophenone

SECTION XX--APPENDIX 2

LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
35.	Butachlor (Machete)	N-(Butoxymethyl)-2-chloro-2',6'--diethylacetanilide
36.	Butylate (Sutan)	S-Ethyl N, N-diisobutylthiocarbamate
37.	Captafol (Difolatan)	N-(1,1,2,2-Tetrachloroethylthio) tetrahydrophthalimide
38.	Captan (Orthocide 406)	N-[(Trichloromethyl)thio]-4--cyclohexene-1,2-dicarboximide
39.	(Carbam-S) (Sodam)	Sodium dimethyldithiocarbamate
40.	Carbaryl (Sevin)	1-Naphthyl N-methylcarbamate
41.	Carbendazim	2-(Methoxycarbonylamino)benzimidazol
42.	Carbofuran (Furadan)	2,3-Dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate
43.	Carbophenothion (Trithion)	S-[(p-Chlorophenylthio)-methyl] 0,0-diethyl phosphorodithioate
44.	Chloramben (Amiben)	3-Amino-2,5-dichlorobenzoic acid
45.	Chlordane* (Octachlor)	1,2,4,5,6,7,8,8-Octachloro--2,3,3a,4,7,7a-hexhydro--4,7-methanoindene
46.	Chlorobenzene*	Monochlorobenzene
47.	Chlorobenzilate (acaraben)	Ethyl 4,4'-dichlorobenzilate
48.	Chlorophacinone	2-[(p-chlorophenyl)phenyl--acetyl]-1,3-indandione

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LIST OF PESTICIDE ACTIVE INGREDIENTS

Common Name	Chemical Name
49. Chloropicrin (Larvacide, Nemax)	Trichloronitromethane
50. Chlorothalonil (Daconil 2787)	2,4,5,6-Tetrachloroisophthalonitrile
51. Chlorpropham	Isopropyl-3-chlorophenyl carbamate
52. Chlorpyrifos (Dursban)	0,0-Diethyl 0-(3,5,6-trichloro-2-pyridyl)phosphorothioate
53. Chlorpyrifos methyl	0,0-Dimethyl 0-(3,5,6-trichloro-2-pyridyl) phosphorothioate
54. Coumachlor	3-(-acetonyl-4-chlorobenzyl)-4-hydroxycoumarin
55. Coumafuryl	4-hydroxy-3-[3-oxo-1-(2-furyl)butyl]coumarin
56. Coumaphos (Co-Ral)	0-(3-Chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl) 0,0-diethyl phosphorothioate
57. Coumatetralyl	4-hyroxy-3-(1,2,3,4-tetrahydro-1-naphthyl)coumarin
58. Cyanazine (Bladex)	2-[(4-Chloro-6-(ethylamino)-S-triazine-2-yl)amino]-2-methylpropionitrite
59. Cycloate (Ro-Neet)	S-Ethyl ethylcyclohexylthiocarbamate
60. Cycloheximide (Actidione)	3[2-(3,5-Dimethyl-2-oxocyclohexyl)-2-hydroxyethyl] glutarimide

SECTION XX--APPENDIX 2

LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
61.	Cycloprate	Hexadecylcyclopropane carboxylate
62.	Cyhexatin	Tricyclohexytin hydroxide
63.	Cythioate (Probam)	0,0-Dimethyl 0-p-sulfamoylphenyl phosphorothioate
64.	2,4-D	2,4-Dichlorophenoxyacetic acid
65.	2,4-D isobutyl ester	2,4-Dichlorophenoxyaxetic acid, technical mixture: Isobutyl ester, 60% N-butyl ester, 40%
66.	2,4-D isooctyl ester	2,4-Dichlorophenoxyacetic acid isooctyl ester 3,4-Dimethylhexanol, 20% 3,5-Dimethylhexanol, 30% 4,5-Dimethylhexanol, 30% 3-Methylheptanol, 15% 5-Methylheptanol, 5%
67.	2,4-D salt	2,4-Dichlorophenoxyacetic acid dimethylamine salt
68.	Dalapon (Dowpon)	2,2-Dichloropropionic acid
69.	Dazomet (Thiadiazin)	Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione
70.	2,4-DB	4-(2,4-Dichlorophenoxy)-butyric-acid
71.	2,4-DB isobutyl ester	4-(2,4-Dichlorophenoxy)-butyric--acid isobutyl ester

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LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
72.	2,4-DB isooctyl ester	4-(2,4-Dichlorophenoxy)-butyric--acid isooctyl ester
73.	DBCP (Dibromochloropropane, Nemagon)	1,2,Dibromo-3-chloropropane and related halogenated C3 hydrocarbons
74.	DCNA (Dichloran, Botran)	(2,6 Dichloro-4-,nitroaniline)
75.	DCPA (Dacthal)	Dimethyl 2,3,5,6-tetrachloro terephthalate
76.	DDD (TDE)*	2,2-Bis(p-chlorophenyl)-1,1-dichloroethane
77.	DDE (DDX)*	1,1-Dichloro-2,2-Bis(p-chlorophenyl) ethylene
78.	DDT*	Dichlorodiphenyl trichloroethane
79.	Deet	NN-Diethyl-m-toluamide
80.	Demeton (Systox)	Mixture of 0,0-diethyl-S(and O)-[2-(ethylthio)ethyl] phosphorothioates
81.	Demeton-o	0,0-Diethyl 0-[2-(ethylthio) ethyl] phosphorothioate
82.	Demeton-s	0,0-Diethyl S-[2-(ethylthio) ethyl] phosphorothioate
83.	Diazinon (Spectracide)	0,0-Diethyl 0-(2-isopropyl-b-methyl-4-pyrimidinyl) phosphorothioate
84.	Dicamba (Banvel D)	2-Methoxy-3,b-dichlorozbenzoic acid
85.	Dichlofenthion (Nemacide)	0-2,4-Dichlorophenyl 0,0-diethyl phosphorothioate

SECTION XX--APPENDIX 2

LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
86.	Dichlorobenzene, ortho*	1,2-Dichlorobenzene
87.	Dichlorobenzene, para*	1,4-Dichlorobenzene
88.	Dichloroethyl ether* (Chlorex)	Bis(2-chloroethyl) ether
89.	Dichlorophen	2,2'-Methylene bis(4-chlorophenol)
90.	Dichlorophen salt	Sodium salt of 2,2'-methylene bis(4-chlorophenol)
91.	D-D (Dichloropropane-dichloropropene mixture)	(60-66%) 1,3-Dichloropropene & (30-35%) 1,2-Dichloropropane & other constitutents
92.	Dichloropropene (Telone)*	1,3-Dichloropropene
93.	Dichlorprop (2,4-DP)	2-(2,4-Dichlorophenoxy)-propionic acid
94.	Dichlorvos (DDVP)	2,2-Dichlorovinyl dimethyl phosphate
95.	Dicofol	1,1-Bis(p-chlorophenyl)-2,2,2-trichloroethanol
96.	Dienochlor (Pentac)	Perchlorobi (cyclopenta-2,4-dien-1-yl)
97.	Dimethoxane (Dioxin)	6-Acetyl-2,4-dimethyl-m-dioxane
98.	Dinocap (Karathane)	2-(1-Methylheptyl)-4,6-dinitrophenyl crotonate
99.	Dinoseb (DNBP)	2-(sec-Butyl)-4,6-dinitrophenol
100.	Dioxathion (Delnav)	s,s'-p-Dioxane-2,3-diyl O,O-diethyl phosphorodithioate (cis and trans isomers)
101.	Diphacinone (Diphacin)	2-Diphenylacetyl-1,3-indandione

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LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
102.	Diphenamid (Enide)	N,N-Dimethyl-2,2-diphenylacetamide
103.	Diphenylamine (DFA)	Diphenylamine
104.	Disulfoton (Di-Syston)	0,0-Diethyl S-[2-(ethylthio)-ethly] phosphorodithioate
105.	Diuron (DCMU)	3-(3,4-Dichlorophenyl)-1-dimethylurea
106.	Dodine (Carpene)	n-Dodecylguanidine acetate
107.	(Dowicil 75)	1-(3-Chlorallyl)-3,5,7-triaza-1-azonia-ad mentane
108.	Endosulfan*	6,7,8,9,10,10-Hexachloro-1,5,5a, 6,9,9a-Hexahydro-6,9-methano-2,4,3-Benzo[e]-dioxathiepin-3-oxide
109.	Endothall (Endothal)	7-oxabicyclo(2,2,1)heptane-2, 3-dicarboxylic acid monohydrate
110.	Endrin*	1,2,3,4,10,-Hexachloro-b, 7-epoxy-1,4,4a,5,6,7,8,8a--octahydro-exo-1,4-exo-5, 8-dimethanonaphthalene
111.	EPN	O-Ethyl O-p-nitrophenyl phenyl phosphonothioate
112.	EPTC (Eptam)	S-Ethyldipropylthiocarbamate
113.	Ethalfluralin (Sonalan)	N-Ethyl-N-(2-methyl-2-propenyl) -2,6-dinitro-4-(trifluoromethyl) aniline
114.	Ethion	0,0,0',0-Tetraethyl S,S'-methylene bisphosphorodithioate
115.	Ethoprop (Mocap)	O-Ethyl S,S,'dipropyl phosphorodithioate

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LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
116.	Ethoxyquin 66%	1,2-Dihydro-6-ethoxy-2,2,4 trimethyl quinoline 60-66%
117.	Ethoxyquin 86%	1,2-Dihydro-6-ethoxy-2,2,4 trimethyl quinoline 80-86%
118.	Ethylene dibromide (EDB)	1,2-Dibromoethane
119.	Etridiazole (Terrazole)	5-Ethoxy-3-trichloromethyl-1,2,4-thiadiazole
120.	EXD (Bisethylxanthogen) (Herbisan)	Diethyl dithiobis(thionoformate)
121.	Famphur (Warbex)	O-[p(Dimethylsulfamoyl)phenyl] O,O-dimethyl phosphorothioate
122.	Fenarimol	a-(2-Chlorophenyl)-a-(4-chlorophenyl)-5-pyrimidine-methanol
123.	Fenitrothion (Sumithion)	0,0-Dimethyl O-(4-nitro-m-tolyl) phosphorothioate
124.	Fensulfothion (Dasanit)	O,O-Diethyl O-[p(methylsulfinyl) phenyl]phosphorothioate
125.	Fenthion (Baytex)	O,O-Dimethyl O-[4-(methyl-thio)--m-tolyl] phosphorothioate
126.	Fentin hydroxide (Du-Ter)	Triphenyltin hydroxide
127.	Fenuron	1,1-Dimethyl-3-phenylurea
128.	Fenuron-TCA	3-Phenyl-1,1-dimethylurea trichloroacetate
129.	Ferbam (Fermate)	Ferric dimethyldithiocarbamate
130.	Fluchloralin (Basalin)	N-Propyl-N-(2-chloroethyl)-a,a,a-trifluoro-2,6-dinitro-p--toluidine

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LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
131.	Fluoridone (EL-171)	1-Methyl-3-phenyl-5[3-(trifluoromethyl)phenyl]-4-(1H)-pyridinone
132.	Fluometuron (Cotoran)	1,1-Dimethyl-3-(3-trifluoromethyl phenyl)urea
133.	Fluoroacetamide	Fluoroacetamide
134.	Folpet (Phaltan)	N-Trichloromethylthio)-phthalimide
135.	Fonofos (Dyfonate)	O-Ethyl S-phenyl ethyl-phosphonodithioate
136.	(Giv-gard)	Beta-bromo-beta nitrostyrene
137.	Glyodin	2-Heptadecyl-2-imidazoline acetate
138.	Glyphosate (Roundup)	N-(Phosphonomethyl)glycine
139.	2-[(Hydroxymethyl) amine]ethanol [HAE]	2-[(Hydroxymethyl)amine] ethanol
140.	2-[(Hydroxymethyl) amine]-2-methyl propanol [HAMP]	2-[(Hydroxymethyl)amine] -2-methyl propanol
141.	Heptachlor*	1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene
142.	Hexachlorophene (Nabac)	2-2'-Methylene bis (3,4,6-
143.	Hexazinone	3-Cyclohexyl-6-(dimethylamino) -1-methyl-1,3,5-triazine-2, 4(1H,3H)-dione
144.	HPTMS	S-(2-Hydroxy propyl) thiomethane Sulfonate
145.	(Hyamine 2389)	Methyl dodecyl benzyl trimethyl ammonium chloride, 80% and Methyl dodecyl xylylene bis(trimethyl ammonium chloride)20%

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LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
146.	(Hyamine 3500)	n-Alkyl (50% C14,40% C12, 10% C16 dimethyl benzyl ammonia chloride
147.	Isopropalin (Paarlan)	2,6-Dinitro-N,N-dipropylcumidine
148.	(Kathon 886)	5-Chloro-2-methyl 4-isothiazolin--3-one and 2 methyl 4-isothiazolin-3-one
149.	Kinoprene	Prop-2-ynyl(+)-(E,E)-3,7,11--trimethyldodeca-2,4-dienoate
150.	(KN methyl)	Potassium N-methyl dithiocarbamate
151.	(Lethane 384)	b-Butoxy-B'thiocyanodiethyl ether
152.	(Lindane) BHC-Gamma*	1,2,3,4,5,6-Hexachlorocyclohexane gamma isomer
153.	Linuron (Afolan, Lorox)	3-(3,4-Dichlorophenyl)-1-methoxy--1-methylurea
154.	Malathion (Mercaptothion, Cythion)	Diethyl mercaptosuccinate S-ester with 0,0-dimethyl phosphorodithioate
155.	Maleic hydrazide	1,2-Dihydropyridazine-3,6-dione
156.	Mancozeb (Dithane M-45)	Coordination product of maneb containing 16 to 20% Mn and 2.0 to 2.5% Zn (zinc) (maneb-manganous ethylene-1, 2-bis-dithiocarbamate)
157.	Maneb (Manzate)	Manganous ethylene-1,2-bis--dithiocarbamate
158.	MCPA	4-Chloro-2-methylphenoxy acetic acid
159.	MCPA isooctyl ester	4-Chloro-2-methylphenoxy isooctly ester

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LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
160.	MCPP	2-Methyl-4-chlorophenoxy propionic acid
161.	Mephosfolan (Cytrolane)	P,P-Diethyl cyclic propylene ester of phosphonodithiomido-carbonic acid
162.	(Merphos) (Folex)	Tributyl phosphorotrithioite
163.	(Metasol DGH)	Dodecylguanidine HCl
164.	(Metasol J-26)	N(1 Nitroethyl benzyl) ethylene diamine 25%
165.	Metham (Vapam, SMDC)	Sodium N-methyldithio carbamate
166.	Methamidophos (Monitor) (Tamaron)	O-S-Dimethyl phosophoroamidothioate
167.	Methiocarb	4-Methylthio-3,5-xylyl methylcarbamate
168.	Methomly (Lannate)	S-Methyl N-[(methylcarbomoyl)-oxy]thioacetimidate
169.	Methoprene (Altosid)	Isopropyl (2E,4E)-11-methoxy-3,7,11-trimethyl-1,4-dodecadienoate
170.	Methoxychlor (Marlate)	2,2-Bis(p-methoxyphenyl)-1,1,1-trichloroethane
171.	Methylbenzethonium chloride (Hyamine 10X)	Benzyldimethyl [2-<2-(p-1,1,3,3-tetramethyl-butylcresoxy)-ethoxy>ethyl] ammonium chloride
172.	Methyl Bromide* (Metabrom)	Bromomethane
173.	Methylene bisthiocyanate (Cytox)	Methylene bisthiocyanate
174.	Metribuzin (Sencor)	4-Amino-6-tert-butyl-3-(methylthio)-1,2,4,triazine-5-one

SECTION XX--APPENDIX 2

LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
175.	Mexacarbate	4-(Dimethylamino)-3,5-xylyl methyl carbamate
176.	Mevinphos (Phosdrin)	Methyl 3-hydroxy-alpha-crotonate, dimethyl phosphate
177.	(MGK 264)	N-(2-Ethylhexyl)bicyclo(2,2,1)-5-heptene-2,3-dicarboximide
178.	(MGK 326)	Di-n-propyl isocinchomeronate
179.	Mirex	Dodecachloro-octahydro-1,3,4-metheno-2h-cyclobuta[c,d] pentalene
180.	Molinate (Ordram)	S-Ethyl hexahydro-1H-azepine-1-carbothioate
181.	Monocrotophos (Azodrin)	Dimethyl phosphate of 3-hydroxy-N-methyl-cis-crotonamide
182.	Monuron	3-(p-chlorophenyl)-1,1-dimethylurea
183.	Monuron-TCA	3-(p-chlorophenyl)-1,1-dimethylurea trichloroacetate
184.	Nabam (Dithane D-14)	Disodium ethylene bis(dithiocarbamate)
185.	(Nabonate)	Disodium cyanodithioimidocarbonate
186.	Naled (Dibrom)	1,2-Dibromo-2,2-dichloroethyl dimethyl phosphate
187.	1,8-Naphthalic anhydride	1,8-Naphthalic anhydride
188.	Napropamide (Devrionl)	2-(a-Naphthoxy)-N,N-diethylpropionamide
189.	Naptalam	N-1-Naphthylphtalamic acid

SECTION XX--APPENDIX 2

LIST OF PESTICIDE ACTIVE INGREDIENTS

Common Name	Chemical Name
190. Neburon	1-n-Butyl-3-(3,4-dichlorophenyl)-1-methylurea
191. (Niacide)	Manganeous dimethyldithiocarbamate
192. Nitrofen (TOK)	2,4-Dichlorophenyl-p-nitrophenyl ether
193. (NMI)	2,6,Bis dimthylamine methyl cyclohexanone
194. Norfluazon (Evital)	4-Chloro-5-(methylamino)-2-(a, a,a-trifluoro-m-tolyl)-2H--pyridazinone
195. Octhilinone (RH-893)	2-n-Octyl-4-isothiazolin--3-one
196. Oryzalin (Surflan)	3,5-Dinitro-N4,N4,dipropylsulfanilamide
197. Quinomethionate	6-methyl-2-oxo-1,3-dithiolo-[4,5b]quinoxaline
198. Oxamyl (Vydate)	Methyl n',n'-diomethyl-N-[(methyl carbomoyl)oxy]-1 thio oxamimidate
199. Oxydemeton (Metasystox-R)	S-[2-(Ethylsufinyl)ethyl-0,0--dimethyl phosphorothioate
200. Oxyfluorfen (Goal)	2-Chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl) benzene
201. Paraquat	1,1'-Dimethyl-4,4'-bipyridalium ion
202. Parathion ethyl	0,0-Diethyl-0-p-nitrophenyl phosphorothioate
203. Parathion methyl	0,0-Dimethyl 0-p-nitro-phenyl phosphorothioate

SECTION XX--APPENDIX 2

LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
204.	PBED (Busan 77)	Poly[oxyethylene(dimethylimino) ethylene(dimethylimino)ethylene dichloride]
205.	(Perthane) Ethylan	1,1-Dichloro-2,2-bis(p-ethylphenyl) ethane
206.	PCNB (Quintozene)	Pentachloronitrobenzene
207.	PCP*	2,3,4,5,6-Pentachlorophenol
208.	PCP salt	2,3,4,5,6-Potassiumpentachlorophenate
209.	Pebulate (Tillman)	S-Propyl butylethylthiocarbamate
210.	Permethrin (Ambush)	m-phenoxybenzyl (+)-cis, trans-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate
211.	Phenylphenol (Dowicide 1)	o-Phenylphenol
212.	Phenylphenol sodium salt (Dowicide A)	Sodium o-phenylphenate
213.	Phorate (Thimet)	0,0-Diethyl S-[(ethylthio)-methyl]phosphorodithioate
214.	Phosfolan (Cyolane)	P,P-Diethyl cyclic ethylene ester of phosphonodithiomido-carbonic acid
215.	Phosmet (Imidan)	0,0-Dimethyl-S-phthalimido-methyl phosphorodithioate
216.	Picloram (Trodon)	4-Amino-3,5,6-trichlor-picolinic acid
217.	Pindone (Pival)	2-Trimethylacetyl-1,3-indandione
218.	Piperalin (Pipron)	3-(2-Methylpiperidino)propyl-3,4-dichlorobenzoate

SECTION XX--APPENDIX 2

LIST OF PESTICIDE ACTIVE INGREDIENTS

Common Name	Chemical Name
219. Piperonyl butoxide (Butacide)	a-[2-(Butoxyethoxy-ethoxy]-4,5-methylenedioxy-2-propyltoluene
220. (Polyphase antimildew)	3-Ido-2 propynyl butyl carbamate
221. Profluralin (Tolban)	N-Cyclopropylmethyl-2,6-dinitro-N-propyl-4-trifluoromethylaniline
222. Prometon (Pramitol)	2,4-Bis(isopropylamino)-6--methoxy-s-triazine
223. Prometryn (Caparol)	2,4-Bis(isopropylamino)-6-(methyl-thio)-S-teiazine
224. Pronamide (Kerb)	3,5-Dichloro-N-(1,1-dimethyl-2--propynyl)benzamide
225. Propachlor (Ramrod)	2-Chloro-N-isopropylacetanilide
226. Propanil (Stam)	3,4-Dichloropropionanilide
227. Propargite (Omite)	2-(p-tert-Butylphenoxy)cyclohexyl 2-propynyl sulfite
228. Propazine (Milogard)	2-Chloro-4,6-bis(isopropylamino)-s-triazine
229. Propham (IPC)	Isopropyl carbanilate
230. Propionic acid	Propanoic acid
231. Propoxur	o-Isoporpoxyphenyl methyl carbamate
232. Pyrethrins	Standardizes mixture of pyrethrin I and II (mixed esters of pyrethrolone
233. 8 Quinolinol citrate	8-Quinolinol citrate
234. 8 Quinolinol sulfate	8-Quinolinol sulfate

SECTION XX--APPENDIX 2

LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
235.	Resmethrin	(5-Benzyl-3-furyl)methyl-2,2 -dimethyl-3-(2-methyl propenyl) cyclopropane carboxylate (approximately 70% trans, 30% Cis isomers)
236.	RH 787 (Vacor)	N-3-Pyridylmethyl N'-nitrophenyl urea
237.	Ronnel (Fenchlorphos)	0,0-Dimethyl 0-(2,4,5-trichlorophenyl)phosphorothioate
238.	Rotenone	1,2,12,12a, Tetrahydro-2-isopropenyl-8,9-dimethoxy-[1]benzopyrano [3,4-b] furo [2,3-b] [1] benzopyran
239.	Siduron (Tupersan)	1-(2-Methylcyclohexyl)-3-phenylurea
240.	Silvex (Fenoprop)	2-(2,4,5-Trichlorophenoxy) propionic acid
241.	Silvex isooctyl ester	Isooctyl ester of 2-(2,4 5-trichlorophenoxy)propionic acid
242.	Silvex salt	Dimethyl amine salt of 2-(2,4,5-trichlorophenoxy) propinoic acid
243.	Simazine (Princep)	2-Chloro-4,5,6-bis(ethyl-amino) -s-triazine
244.	Simetryne (Gybon)	2-Methylthio-4,6-bis-ethylamino -s-triazine
245.	Sodium monofluoroacetate	Sodium monofluoroacetate
246.	Stirofos (Tetrachlorvinphos)	2-Chloro-1-(2,4,5-trichlorophenyl vinyl dimethyl phosphate
247.	Sulfallate (CDEC)	2-Chloroallydiethyldithiocarbamate
248.	Sulfoxide	1,methyl-2-(3,4-methylenedioxyphenyl)ethyl octyl sulfoxide

LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
249.	Swep	Methyl N-(3,4-dichlorophenyl) carbamate
250.	2,4,5-T	2,4,5-Trichlorophenoxyacetic acid
251.	TCMTB	2-[Thiocyanomethythio] benzothiazole
252.	Tebuthiuron	1-(5-tert-Butyl-1,2,4-thia-diazol -2-yl)-1,3-dimethylurea
253.	Temephos (Abate)	0,0-Dimethyl phosphorothioate 0,0-diester with 4,4'-thio-diphenol
254.	Terbacil (Sinbar)	3(tert-Butyl)-5-chlor-6-methyl uracil
255.	Terbufos (Counter)	5-tert-Butylthiomethyl 0,0-dimethyl phosphorodithioate
256.	Terbuthylazine (GS 13529)	2-tert-Butylamino-4-chloro -6-ethylamino-1,3,5-triazine
257.	Terbutryn (Igran)	2-(tert-Butylamino)-4- -(ethyl-amino)-6-(methylthio) -s-triazine
258.	Thiabendazole (Mertect)	2-(4'-Thiazolyl) benzimidazole
259.	Thiofanox (DS-15647)	3,3-Dimethyl-1-(methylthio) -2-butamone 0-[(methylamino) -carbonyl] oxine
260.	Thionazine (Nemafos)	0,0-Diethyl 2-pyrazinyl phosphorothioate
261.	(Tokuthion) (NTN 8629) Prothiofos	0,-2,4-Dichlorophenol-0-ethyl-s-propyl phosphorodithioate
262.	Toxaphene (Camphechlor)*	A mixture of chlorinated camphene compounds of uncertain identity (combined chlorine 67-69%)

LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
263.	Triadimefon (Bayleton)	1-(4-Chlorophenoxy)-3,3--dimethyl-1-(1,2,4-triazol-1-yl) buton-2-one
264.	Tributyltin benzoate	Tributyltin benzoate
265.	Tributyltin fluoride	Tributytin fluoride
266.	Tributyltin oxide	Bis(tri-n-butyltin) oxide
267.	Trichlorobenzene (TCB)*	1,2,4-Trichlorobenzene
268.	Trichloronate	0-ethyl 0-(2,4,5-trichlorophenyl)ethylphosphorothioate
269.	Tricyclazole	5-Methyl-1,2,4-triazolo [3A-b] Benzothiazole
270.	Trifluralin (Treflan)	a,a,a-Trifluoro-2,6-dinintro--N,N-Dipropyl-p-toluidine
271.	(Vancide TH)	Hexahydro-1,3,5-triethyl-s--triazine
272.	(Vancide 51Z)	Zinc dimethyldithiocarbamate and Zinc 2-mercaptobenzothiazole
273.	(Vancide 51Z dispersion)	50% Zinc dimethylydithiocarbamate and Zinc 2-mercaptobenzothiazole 50% water
274.	(Vancide PA)	0-ethyl 0-(2,4,5-trichlorophenyl)ethylphosphorothioate
275.	Vernolate (Vernam)	S-Propyl N,N-dipropylthiocarbamate
276.	Warfarin	4-hydroxy-3-(3-oxo-1-phenylbutyl)coumarin
277.	[ZAC] (zinc ammonium carbonate)	Ammoniates of [ethylenebis (dithiocarbamate)]-zinc

LIST OF PESTICIDE ACTIVE INGREDIENTS

	Common Name	Chemical Name
278.	Zineb	Zinc ethylenebisdithiocarbamate
279.	Ziram (Vancide MZ-96)	Zinc dimethyldithiocarbamate

Under the column titles common name ( ) = trade name

Under the column titled common name [ ] = contractor abbreviation for pesticides that have no common name and an extensive chemical name.

*Pesticide active ingredients which are also priority pollutants.

SECTION XX--APPENDIX 3

BPT EFFLUENT LIMITATIONS GUIDELINES

The following pesticides were excluded from BPT regulations according to the April 25, 1978 Federal Register:

Allethrin
Benzyl benzoate
Biphenyl
Bisethylxanthogen*
Chlorophacinone
Coumafuryl
Dimethyl phthalate
Diphacinone
Endothall acid
EXD (Herbisan)*
Gibberellic acid
Glyphosate
Methoprene
Naphthalene acetic acid
1,8-Napthalic anhydride
Phenylphenol
Piperonyl butoxide
Propargite
Quinomethionate
Resmethrin
Rotenone
Sodium phenylphenate
Sulfoxide
Triazine compounds (both symmetrical and asymmetrical)
Warfarin and similar anticoagulants

* Although originally listed as two compounds, it has been determined that the two are the same. EXD is the common name used throughout this regulation; bisethylxanthogen is a trade name.

The following pesticides were regulated for the direct discharge to navigable waters of BOD, COD, TSS, Pesticides, and pH according to the September 29, 1978 Federal Register as listed below:

Aldrin
Aminocarb
Azinphos methyl
Barban
BHC
Captan
Carbaryl
Chlordane
Chlorpropham
2,4-D
DDD
DDE
DDT
Demeton-O
Demeton-S
Diazinon
Dicamba
Dichloran
Dicofol
Dieldrin
Disulfoton
Diuron
Endosulfan
Endrin
Fenuron
Fenuron-TCA
Heptachlor
Lindane
Linuron
Malathion
Methiocarb
Methoxychlor
Mexacarbate
Mirex
Monuron
Monuron-TCA
Neburon
Parathion ethyl
Parathion methyl
PCNB
Perthane
Propham
Propoxur
Siduron
Silvex
SWEP
2,4,5-T
Trifluralin
Toxaphene

SECTION XX--APPENDIX 3

BPT EFFLUENT LIMITATIONS GUIDELINES

(Continued, Page 2 of 2)

All other manufactured pesticides were regulated for the direct discharge to navigable waters of BOD, COD, TSS, and pH according to the September 29, 1978 Federal Register as listed below:

Subcategory*	Effluent Characteristic	Effluent Limitations: Average of Daily Values for 30 Consecutive Days	Effluent Limitations: Daily Maximum
1	BOD_5	1.6	7.4
	COD	9.0	13.0
	TSS	1.8	6.1
	Pesticide Chemicals	0.0018	0.010
	pH†		
2	NO DISCHARGE OF PROCESS WASTEWATER POLLUTANTS		
3	NO DISCHARGE OF PROCESS WASTEWATER POLLUTANTS		

Note: All units are kg/kkg

* Subcategory 1: Organic Pesticide Chemicals Manufacturing
Subcategory 2: Metallo-Organic Pesticide Chemicals Manufacturing
Subcategory 3: Pesticide Chemicals Formulating and Packaging

† The pH shall be between the values of 6.0 to 9.0

SECTION XX - APPENDIX 4

CONVERSION TABLE

Multiply (English Units)		By	To Obtain (Metric Units)	
English Unit	Abbreviation	Conversion	Abbreviation	Metric Unit
acre	ac	0.405	ha	hectares
acre-feet	ac ft	1233.5	cu m	cubic meters
British Thermal Unit	BTU	0.252	kg cal	kilogram-calories
British Thermal Unit/pound	BTU/lb	0.555	kg cal/kg	kilogram calories per kilogram.
cubic feet per minute	cfm	0.028	cu m/min	cubic meters per minute
cubic feet per second	cfs	1.7	cu m/min	cubic meters per minute
cubic feet	cu ft	0.028	cu m	cubic meters
cubic feet	cu ft	28.32	1	liters
cubic inches	cu in	16.39	cu cm	cubic centimeter
degree Fahrenheit	°F	0.555(°F-32)*	°C	degree Centigrade
feet	ft	0.3048	m	meters
gallon	gal	3.785	1	liter
gallon per minute	gpm	0.0631	1/sec	liters per second
gallon per ton	gal/ton	4.173	1/kkg	liters per metric ton

* Actual conversion, not a multiplier

CONVERSION TABLE

Multiply (English Units)		By	To Obtain (Metric Units)	
English Unit	Abbreviation	Conversion	Abbreviation	Metric Unit
horsepower	hp	0.7457	kw	kilowatts
inches	in	2.54	cm	centimeters
pounds per square inch	psi	0.06803	atm	atmosphere (absolute)
million gallons per day	MGD	3.7 x 10^{-3}	cu m/day	cubic meters per day
pounds per square inch (gauge)	psi	(0.06805 psi + 1 TM)	atm	atmospheres
pounds	lb	0.454	kg	kilograms
pounds	lb	454,000	mg	milligrams
ton	ton	0.907	kkg	metric ton
mile	mi	1.609	km	kilometer
square feet	ft^2	0.0929	m^2	square meters

* Actual conversion, not a multiplier.

Section XX-APPENDIX 5

FORM APPROVED
OMB No. 2040-0041
EXPIRES June 30, 1984

QUESTIONNAIRE

FORMULATING/PACKAGING SEGMENT OF THE PESTICIDE CHEMICALS INDUSTRY

U.S. ENVIRONMENTAL PROTECTION AGENCY

INTRODUCTION

The Environmental Protection Agency is conducting this survey in support of rulemaking to control pollutants in wastewaters discharged by pesticide chemicals formulator/packagers (PFP), one segment of the pesticide chemicals industry. The objective of the questionnaire is to obtain information on current PFP plant operations and on wastewater control and treatment practices.

Facilities covered by this survey are those classified as agricultural and/or household pest control chemicals formulator/blendor/repackagers under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) that currently discharge wastewater to Publicly Owned Treatment Works (POTWs). These plants formulate and/or package pesticide active ingredients and may, in the process, generate wastewater contaminated by priority, conventional, and/or nonconventional pollutants. More specifically, these plants physically mix technical grade pesticide ingredients into liquids, dusts and powders, or granules and then package these products into marketable containers.

All pesticide manufacturers are required under FIFRA to register their products with the EPA Office of Pesticides and Toxic Substances. The Effluent Guidelines Division used this registration information to identify your plant as a formulator/packager, and it used a telephone survey to identify your plant as an indirect discharger. The information obtained from the PFP survey will be analyzed in addition to the FIFRA production data in order to promulgate effluent guidelines for pesticide formulator/packagers that are indirect dischargers.

This questionnaire is organized into six parts: (1) General Information; (2) Plant Characteristics; (3) Plant Personnel; (4) Plant Operations: Formulating/Packaging Production; (5) Wastewater Generation/Characteristics; (6) Wastewater Treatment/Control Technology. Definitions of terms used in the questionnaire are given at the back of the document. To aid the respondent, instructions have been incorporated into the questionnaire. Space has been provided so that responses may be given directly on the questionnaire. Additional sheets should be attached if more space is needed.

In parts II through VI of the questionnaire, pesticide formulation/packaging (PFP) operations refer exclusively to operations for the formulation and/or packaging of agricultural and/or household pesticide control chemicals such as insecticides, fungicides and herbicides from technical grade chemicals or concentrates.

QUESTIONNAIRE
PESTICIDE
FORMULATING/PACKAGING

QUESTIONNAIRE CONTENTS

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PART I. GENERAL INFORMATION

The information requested in this section is necessary to identify the plant and to determine whether the plant is conducting activities relevant to this survey.

1. Name and Address of Plant ______________________

   Street ______________________

   City ______________ State __________ Zip Code ______

2. Plant Contact: Name ______________________

   Title ______________________

   Telephone ______________________

3. Respondent (if different from above):

   Name ______________________

   Title ______________________

   Telephone ______________________

Company Name ____________________

PART I. Continued

Plant Name ______________________

4. In 1982, did you formulate and/or package nonagricultural pest control chemicals such as disinfectants and sanitizers, inorganics and surface active agents? (Do not include these products as PFP products in the remaining parts of this questionnaire. See note at top of page 3). (See below for definitions of formulating and packaging)

Yes______________ No________

5. In 1982, was this plant engaged in pesticide formulating and/or packaging (PFP) of agricultural or household pest control chemicals such as insecticides, fungicides and herbicides from technical grade chemicals or concentrates? (See below for definitions of formulating and packaging)

Yes________ No_________

If NO, please stop here and return the questionnaire.

If YES, proceed with the following questions.

6. In 1982, did this plant discharge water or any other liquid to a waste treatment facility not owned by the plant? Yes______ No_____

If NO, please stop here and return the questionnaire.

If YES, proceed with the following questions.

Pesticide Packaging: The transfer and packaging of formulated products into a marketable container.

Pesticide Formulating: The physical processing of pesticide active ingredients into wettable powders, granules, and emulsifiable concentrates.

PLEASE NOTE:

In Parts II through VI , pesticide formulating/packaging (PFP) operations refer exclusively to operations for the formulation and/or packaging of agricultural and/or household pest control chemicals such as insecticides, fungicides and herbicides from technical grade chemicals or concentrates.

PART II. PLANT CHARACTERISTICS

This section requests data that will be used in determining the costs and economic achievability of effluent regulations.

1. Area (square feet) of the buildings on the site:

   a. Total plant area: ____________________

   b. Total plant area used anytime in 1982 for pesticide formulating/packaging: ____________________

   c. Percent of area in 1.b. used exclusively for pesticide formulating/packaging: ____________________

2.* Investment costs for pesticide formulating/packaging operations only:

See Definitions for "bookvalue" and "investment cost."

	Building	Equipment
a. Total 1982 bookvalue net of depreciation:	________	________
b. Total investment for 1978-1982:	________	________

3.* 1982 operating and maintenance costs (labor, raw material, and energy) for the PFP operations at the plant: ____________________

4.* 1982 interest and depreciation costs and other general administrative and overhead costs for PFP operations at the plant: ____________________

5.* a. Capital cost of plant facilities used for treatment of process wastewater associated with PFP operations: ____________________

b. Year investment made: ____________________

* If the cost or an estimate of the cost is not available, provide an estimated cost in proportion to the pounds of formulated PFP products and indicate that your answer is an estimate by an "E" after the value.

Company Name ____________________

Plant Name ____________________

PART III. PLANT PERSONNEL (1982)

Employment data will be used to determine the degree to which the plant is dedicated to PFP operations and the impact of effluent regulations on plant personnel.

1. Indicate the number of weeks in 1982 during which the plant formulated/packaged pesticide products: ____________________

2. Provide the number of employees for the pay period which includes the 12th day of the designated months in 1982 and the total hours worked for 1982.

Activity	Number of Employees*				Estimated Total Hours Worked 1982
	Mar.	May	Aug.	Nov.	
a. Production: Formulating/ packaging pesticide products					
Production: Other production					
b. Nonproduction					

*An employee who worked in production of PFP products and in other production during the pay period which includes March 12 would be counted in both categories.

Nonproduction employees include supervisory, clerical and other support personnel.

Company Name ____________________

PART IV. PLANT OPERATIONS:

Plant Name ____________________

FORMULATING/PACKING PRODUCTION (1982)

This part requests information on total plant production and on each different pesticide product. EPA will use the information obtained from this part together with the production data provided by your plant under FIFRA in conducting the necessary economic and engineering analyses of this segment of the industry.

1. Percentage of total plant production (weight in pounds) attributable to PFP operations in 1982: ____________________

2. Percentage of active ingredient used in PFP operations that was produced at the plant in 1982: ____________________

3. Total market value (dollars) of pesticide products formulated or packaged at this plant in 1982: ____________________

4. Total market value (dollars) of all plant production: ____________________

5. Provide the following information on Table IV.5 for each different pesticide product formulated/packaged (PFP) during 1982. To group products, see Appendix A.

   a. FIFRA product number or Group Code for PFP products.

   b. Number of production days. If a Group Code is used then the number of production days is the number of days in 1982 on which at least one of the products was produced. For example, if three products from Group Code A were produced on July 14, 1982, this counts as one production day.

   c. Type of formulation Base (D = dry formulation, S = solvent formulation, W = water formulation)

   d. Total market value of processed (PFP) product (dollars)

   e. Common names of each pesticide active ingredient contained in formulation

   f. Name of solvents used (if none, write none)

   g. Quantity (gals) of solvents used (if none, write none).

   If additional space is needed, make additional copies of the table before entering data.

PART IV. Continued

Company Name ____________

Plant Name ____________

5. Formulating/Packaging Production (1982)

FIFRA Pesticide Product Number*or Group Code	Number of Production Days	Type of Formulation Base	Total Value of Processed Product (dollars)	Names of Active Ingredients	Solvents Used	
					Name	Quantity (gals.)

* Number assigned under Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

Company Name ____________________

Plant Name ____________________

PART V. WASTEWATER GENERATION/ CHARACTERISTICS (1982)

The data requested in this section will be used to determine the source and amount of wastewater generated by PFP operations. This information is important in analyzing the existing treatment/control technology. If the information is not available or estimated for PFP operations, provide an estimate based on your answer to questions IV.1 and the plant totals. Indicate these estimates by an "E" following the estimate.

1. Pesticide Process Wastewater:	Flow per typical operating day (gals.)	Total annual flow (gals.)
a. Chemical Processing (solvent water, wash water)		
b. Vessel or floor washdown of formulating/packaging area		
c. Vent scrubbers for the formulating/packaging area		
d. Runoff from the formulating/packaging area		
e. Laboratory wastewater		
f. Other (specify) ____________		

2. Non-contact Wastewater:	Flow per typical operating day (gals.)	Total annual flow (gals.)
a. Cooling water		
b. Boiler blowdown		
c. Stormwater runoff (not contaminated by pesticide contact)		
d. Toilet sewage		
e. Other (specify) ____________		

3. Potentially Contaminated Wastewater	Flow per typical operating day (gals.)	Total annual flow (gals.)
a. Laundry		
b. Shower/lavatory		
c. Other (specify) ____________		

Company Name ____________________

Plant Name ______________________

PART VI. WASTEWATER TREATMENT/ CONTROL TECHNOLOGY (1982)

The information requested in this section will be used to conduct technical and economic analyses pertinent to recommended treatment.

1. What is the total plant process (contact) wastewater generated, including wastewater generated in PFP operations, during 1982?

____________________ gals

2. Provide the following information regarding the disposal of process (contact) wastewater generated during 1982 as a consequence of the formulating/packaging of the products listed in Table IV.5. Use the attached Table VI.2:

   a. Pesticide product: Use the same combinations of products used to answer Part IV.5.

   b. Wastewater flow on a typical operating day (gals.). If not available or estimated for PFP operations, provide an estimate based on your answer to questions IV.1 and the plant totals. Indicate these estimates by an "E" following the estimate.

   c. Total annual wastewater flow (gals.)

   d. A list of all treatment or control units employed in the disposal of wastewater (in order of use)

   Use the following abbreviations, as necessary:

   AC - Activated Carbon Adsorption
   AL - Aerated Lagoon
   BO - Biological Oxidation
   CH - Contract Hauling
   CO - Chemical Oxidation
   DW - Deep Well Injection
   EQ - Equalization
   EV - Evaporation
   GS - Gravity Separation
   HD - Hydrolysis
   IN - Incineration
   LA - Land Application
   MF - Multimedia Filtration
   MS - Metals Separation
   NE - Neutralization
   RA - Resin Adsorption
   RR - Recycle/Reuse
   SS - Steam Stripping
   TF - Trickling Filter System

   e. If no treatment/control units are used, write NONE.

PART VI. Continued

Company Name ______________________

Plant Name ______________________

2. Wastewater generation, treatment, and control (1982)

FIFRA Pesticide Product Number or Group Code	Wastewater Discharge Flow (gals.)		Wastewater Treatment/Control Treatment/Control Units (in order)
	Typical Day	Annually	

Company Name ____________________

PART VI. Continued

Plant Name ____________________

Year for which
data are provided ______________

3. Complete the following table for samples collected for any chemical analyses of treated or pretreated effluent during 1982. If data are unavailable for 1982, provide the most recent information available. Use additional copies of this sheet as necessary.

IDENTIFY EFFLUENT STREAM*	NUMBER OF SAMPLES	TYPE OF SAMPLE**	CONSTITUENTS	AVERAGE CONCENTRATION (mg/l)	DISSOLVED OR TOTAL (CIRCLE ONE)	ANALYTICAL METHOD***
					D T D T D T D T D T	
					D T D T D T D T D T	
					D T D T D T D T D T	
					D T D T D T D T D T	

* By treatment/control unit, by FIFRA Product Number or by Product Group Code

** Grab or composite.

*** Standard methods, EPA, ASTM, or other (specify).

Company Name ____________________

PART VI. Continued

Plant Name ______________________

4. a. Specify the 1982 cost of operating and maintaining plant facilities used for treatment of process wastewater associated with PFP processes: ______________________________

   b. Specify the 1982 cost of off-site disposal of PFP process wastewater: ______________________________

5. a. Specify the amount (lbs. or tons) of hazardous waste generated during 1982 for PFP operations (answer even if plant is exempt from regulation as a small generator): ____________________

   b. Specify in Table VI.5 the location and method of hazardous waste disposal and indirect treatment or disposal method(s) practiced (answer even if small generator):

6. If the pretreatment standard of zero discharge were imposed please list all the options available to your plant to comply (e.g. contract haul, incineration evaporation, etc.)

Company Name ____________________

Plant Name ____________________

PART VI. Continued

5. Hazardous Waste Disposal

	Pounds Disposed in 1982			
	Location		Operator	
Method	On Site	Off Site	Self	Contract
Direct discharge to navigable waterway.				
Municipal waste treatment facility of POTW.				
No-discharge incineration.				
No-discharge evaporation.				
Land Disposal				
Other (specify)				
If methods unknown, please provide name and address of contract hauler.				

DEFINITIONS OF TERMS USED IN QUESTIONNAIRE

Bookvalue Net of Depreciation - Total investment cost minus depreciation.

Conventional Pollutants -- For the Pesticide Industry conventional pollutants are defined as BOD, TSS, and pH.

Investment Cost - For a property is the amount paid either directly or in-kind at the time of the transaction.

Noncontact Wastewater - Wastewater which is not contaminated by pesticide active ingredients or solvents. Stormwater from outside the formulating and packaging areas is included in this definition if it is not contaminated from product spills, etc.

Nonconventional Pollutants -- For the Pesticide Industry nonconventional pollutants are defined as nonpriority pollutant pesticides, COD, ammonia, and manganese.

Pesticide Formulating - The physical processing of pesticide active ingredients into wettable powders, granules, and emulsifiable concentrates.

Pesticide Packaging - The transfer and/or packaging of formulated products into a marketable container.

POTW - Publicly Owned Treatment Works

Priority Pollutant -- Those 126 compounds specified as an outgrowth of the 1976 Consent Decree.

Process Wastewater - Any aqueous discharge which results from contact with pesticide active ingredients or solvents, including:

1. Reaction wastewater or dilution water used directly in the process.
2. Wastewater from vessel or floor washdown in the immediate formulating/packaging area.
3. Runoff from the formulating/packaging areas, and other areas where pesticide contamination occurs.
4. Wastewater from pollution control devices, such as vent scrubbers in the immediate formulating/packaging area.

Zero Discharge - No discharge of PFP process (contact) wastewater (no flow).

APPENDIX A

Product Grouping

Products may be combined into groups if all of the following criteria are met:

i. All products contain the same active ingredients(s).

ii. If solvents are used, products contain the same solvent(s).

iii. All products have the same type of formulation base (dry, solvent or water).

iv. All products are formulated and/or packaged on the same equipment or similiar equipment that would result in the same volume and concentration of waste load generated per unit of production.

Label each product group by a group code A,B,C, etc. In each column below, list the FIFRA products grouped under each product code.

GROUP CODES

A	B	C	D	E	F	G
______	______	______	______	______	______	______
______	______	______	______	______	______	______
______	______	______	______	______	______	______
______	______	______	______	______	______	______
______	______	______	______	______	______	______
______	______	______	______	______	______	______
______	______	______	______	______	______	______

SECTION XX- APPENDIX 6

Priority Pollutants Regulated in Organic Pesticide Chemicals Manufacturing Wastewaters Subcategory

Column A Pesticide Active Ingredient	Column B Priority Pollutant Regulated
Acephate	Methylene chloride Toluene
Alachlor	1,2-Dichloroethane Chlorobenzene
Aldicarb	
Alkylamine hydrochloride	
Allethrin	
Ametryne	Cyanide Toluene
Aminocarb	
Amobam	
Anilazine	1,2-Dichloroethane Cyanide
AOP	
Aquatreat DNM 30	
Aspon	Toluene
Atrazine	Cyanide Carbon tetrachloride Toluene
Azinphos methyl	1,2-Dichloroethane
Barban	Toluene 1,2-Dichloroethane
BBTAC	

SECTION XX- APPENDIX 6

Priority Pollutants Regulated in Organic Pesticide Chemicals Manufacturing Wastewaters Subcategory

Bendiocarb	
Benfluralin	
Benomyl	
Bensulide	Benzene Toluene
Bentazon	Carbon tetrachloride Chlorobenzene
Benzethonium chloride	Toluene
Benzyl benzoate	
Benzyl bromoacetate	Benzene Toluene
BHC	a-BHC-Alpha b-BHC-Beta d-BHC-Delta g-BHC-Gamma Benzene Chlorobenzene
Bifenox	Methyl chloride 2,4-Dichlorophenol Phenol
Biphenyl	Benzene
Bolstar	Toluene
	2,4-Dichlorophenol Phenol
Bromacil	Methylene chloride
Bromoxynil	Benzene Toluene
Bromoxynil octanoate	Benzene Toluene
Busan 40	

SECTION XX- APPENDIX 6

Priority Pollutants Regulated in Organic Pesticide Chemicals Manufacturing Wastewaters Subcategory

Busan 85	
Busan 90	1,2-Dichloroethane Methylene chloride Phenol
Butachlor	1,2-Dichloroethane
Butylate	Methylene chloride
Captafol	Toluene
Captan	
Carbam-S	
Carbaryl	Toluene
Carbendazim	
Carbofuran	Methylene chloride
Carbophenothion	Benzene Chlorobenzene
Chloramben	
Chlordane	Hexachlorocyclopentadiene Heptachlor
Chlorobenzene	Benzene Chlorobenzene
Chlorobenzilate	Cyanide
Chlorophacinone	
Chloropicrin	
Chlorothalonil	Tetrachloroethylene Cyanide Carbon tetrachloride
Chlorpropham	1,2-Dichloroethane Tetrachloroethylene

SECTION XX- APPENDIX 6

Priority Pollutants Regulated in Organic Pesticide Chemicals Manufacturing Wastewaters Subcategory

Chlorpyrifos	Methylene chloride
Chlorpyrifos methyl	Methylene chloride
Coumachlor	
Coumafuryl	
Coumaphos	
Coumatetralyl	
Cyanazine	Cyanide
Cycloate	Methylene chloride
Cycloheximide	Methylene chloride
Cycloprate	Toluene
Cyhexatin	Benzene Toluene
Cythioate	Benzene Toluene
2,4-D	2,4-Dichlorophenol Phenol Toluene (plants 4 and 5 only)
2,4-D isobutyl ester	2,4-Dichlorophenol
2,4-D isooctyl ester	2,4-Dichlorophenol (plant 6 on
2,4-D salt	
Dalapon	
Dazomet	
2,4-DB	Methylene chloride 2,4-Dichlorophenol Phenol

SECTION XX- APPENDIX 6

Priority Pollutants Regulated in Organic Pesticide Chemicals Manufacturing Wastewaters Subcategory

2,4-DB isobutyl ester	
2,4-DB isooctyl ester	
DBCP	
DCNA	
DCPA	Carbon tetrachloride Benzene Toluene
D-D	
DDD	Chlorobenzene
DDE	Chlorobenzene Chlorobenzene
DDT	Benzene
Deet	Benzene Toluene
Demeton	Toluene
Demeton-o	Toluene Copper
Demeton-s	Copper Toluene
Diazinon	Toluene
Dicamba	Methyl chloride 2,4-Dichlorophenol Benzene Toluene
Dichlofenthion	2,4-Dichlorophenol Phenol

SECTION XX- APPENDIX 6

Priority Pollutants Regulated in Organic Pesticide Chemicals Manufacturing Wastewaters Subcategory

Dichlorobenzene, ortho	Chlorobenzene 1,2-Dichlorobenzene
Dichlorobenzene, para	Chlorobenzene 1,4-Dichlorobenzene
Dichloroethyl ether	Bis(2-chloroethyl)ether+

+ = Regulated as a priority pollutant only in those processes in which it is the manufactured product.

Dichlorophen	Phenol Toluene
Dichlorophen salt	
Dichloropropene	1,3-Dichloropropene+

+ = Regulated as a priority pollutant only in those processes in which it is a manufactured product

Dichlorprop	Phenol 1,4-Dichlorophenol
Dichlorvos	Methyl chloride
Dicofol	1,2-Dichloroethane Chlorobenzene Toluene Cyanide
Dienochlor	Hexachlorocyclopentadiene Copper Toluene
Dimethoxane	
Dinocap	2,4-Dinitrophenol 4-Nitrophenol Phenol
Dinoseb	Phenol 2,4-Dinitrophenol
Dioxathion	Benzene
Diphacinone	

SECTION XX- APPENDIX 6

Priority Pollutants Regulated in Organic Pesticide Chemicals Manufacturing Wastewaters Subcategory

Diphenamid	Benzene
Diphenylamine	
Disulfoton	Toluene
Diuron	Chlorobenzene Carbon tetrachloride
Dodine	Cyanide
Dowicil 75	
Endosulfan	Hexachlorocyclopentadiene a-Endosulfan-Alpha b-Endosulfan-beta Benzene Toluene
Endothall	
Endrin	Hexachlorocyclopentadiene Endrin
EPN	4-Nitrophenol Phenol Toluene
EPTC	Methylene chloride
Ethalfluralin	
Ethion	Methylene chloride Methyl bromide Toluene
Ethoprop	
Ethoxyquin 66%	
Ethoxyquin 86%	
Ethylene dibromide	

SECTION XX- APPENDIX 6

Priority Pollutants Regulated in Organic Pesticide Chemicals Manufacturing Wastewaters Subcategory

Etridazole	Chloroform
EXD	
Famphur	Benzene Toluene
Fenarimol	Chlorobenzene Toluene
Fenitrothion	Copper (plant 8 only) Toluene
Fensulfothion	Copper Toluene
Fenthion	Toluene
Fentin hydroxide	Chlorobenzene Phenol
Fenuron	
Fenuron-TCA	Benzene Toluene
Ferbam	
Fluchloralin	
Fluoridone	Chloroform Toluene
Fluometuron	Cyanide
Fluoroacetamide	
Folpet	
Fonofos	Toluene
	Phenol
Giv-gard	Toluene

SECTION XX- APPENDIX 6

Priority Pollutants Regulated in Organic Pesticide Chemicals Manufacturing Wastewaters Subcategory

Glyodin	
Glyphosate	
HAE	
HAMP	
Heptachlor	Hexachlorocyclopentadiene Carbon tetrachloride Heptachlor
Hexachlorophene	1,2-Dichloroethane Phenol 2,4-Dichlorophenol
Hexazinone	Toluene
HPTMS	
Hyamine 2389	Toluene
Hyamine 3500	
Isopropalin	
Kathon 886	Toluene
Kinoprene	
KN methyl	
Lethane 384	Cyanide
Lindane	a-BHC-Alpha b-BHC-Beta d-BHC-Delta g-BHC-Gamma Benzene Chlorobenzene
Linuron	Chlorobenzene Carbon tetrachloride
Malathion	Toluene

SECTION XX- APPENDIX 6

Priority Pollutants Regulated in Organic Pesticide Chemicals Manufacturing Wastewaters Subcategory

Maleic hydrazide	
Mancozeb	Zinc
Maneb	Zinc (plant 9 only)
MCPA	Phenol Toluene
MCPA isooctyl ester	
MCPP (Mecoprop)	Phenol Toluene
Mephosfolan	Toluene
Merphos	
Metasol DGH	Cyanide
Metasol J-26	
Metham	
Methamidophos	1,2-Dichloroethane
Methiocarb	
Methomyl	Methylene chloride
Methoprene	
Methoxychlor	Phenol
Methylbenzethonium chloride	Toluene
Methyl bromide	Methyl bromide
Methylene bisthiocyanate	Cyanide Methyl bromide Methylene chloride
Metribuzin	Methyl bromide
Mevinphos	Methyl chloride
Mexacarbate	

SECTION XX- APPENDIX 6

Priority Pollutants Regulated in Organic Pesticide Chemicals Manufacturing Wastewaters Subcategory

MGK 264	Toluene
MGK 326	Benzene
Mirex	Hexachlorocyclopenta-Diene
Molinate	Methylene chloride
Monocrotophos	Chloroform Copper
Mon	
Monuron-TCA	Benzene Toluene
Nabam	
Nabonate	Cyanide
Naled	Carbon tetrachloride
1,8-Napthalic anhydride	
Napropamide	Toluene Chlorobenzene
Naptalam	Benzene Toluene
Neburon	Carbon tetrachloride Chlorobenzene
Niacide	
Nitrofen	2,4-Dichlorophenol 4-Nitrophenol Benzene Toluene
NMI	Toluene
Norflurazon	

SECTION XX- APPENDIX 6

Priority Pollutants Regulated in Organic Pesticide Chemicals Manufacturing Wastewaters Subcategory

Octhilinone	
Oryzalin	Toluene
Oxamyl	
Oxydemeton	Toluene Copper
Oxyfluorfen	Tetrachloroethylene
Paraquat	Methyl chloride
Parathion ethyl	4-Nitrophenol Benzene Toluene
Parathion methyl	4-Nitrophenol Benzene Toluene
PBED	1,2-Dichloroethane
PCNB	Pentachlorophenol 1,2,4-trichlorobenzene
PCP	Pentachlorophenol Phenol
PCP salt	Phenol Pentachlorophenol
Pebulate	Methylene chloride Zinc
Pendimethalin	Benzene Toluene
Perfluidone	
Permethrin	
Perthane	

SECTION XX- APPENDIX 6

Priority Pollutants Regulated in Organic Pesticide Chemicals Manufacturing Wastewaters Subcategory

Phenylphenol	Phenol Benzene Chlorobenzene
Phenylphenol sodium salt	Phenol Benzene Chlorobenzene
Phorate	
Phosfolan	Toluene
Phosmet	Benzene
Picloram	Cyanide Carbon tetrachloride
Pindone	Benzene (plant 12 only)
Piperalin	Chlorobenzene Toluene
Piperonyl butoxide	
Polyphase antimildew	
Profluralin	Benzene Toluene
Prometon	Cyanide Toluene
Prometryn	Cyanide Toluene
Pronamide	Toluene
Propachlor	1,2-Dichloroethane
Propanil	Toluene (plants 14 and 15 only
Propargite	
Propazine	Cyanide Carbon tetrachloride (plant 16
Propham	

SECTION XX- APPENDIX 6

Priority Pollutants Regulated in Organic Pesticide Chemicals Manufacturing Wastewaters Subcategory

Propionic acid	
Propoxur	
Pyrethrins	
8 Quinolinol citrate	
8 Quinolinol sulfate	
Quinomethionate	
Resmethrin	Toluene
RH-787	
Ronnel	2,4-Dichlorophenol Phenol
Rotenone	Toluene
Siduron	
Silvex	2,4-Dichlorophenol Phenol Toluene (plant 17 only)
Silvex isooctyl ester	
Silvex salt	
Simazine	Cyanide Carbon tetrachloride (plant 18 Toluene (plant 18 only)
Simetryne	Cyanide Toluene
Sodium monofluoroacetate	
Stirofos	Methyl chloride
Sulfallate	2,4-Dichlorophenol
Sulfoxide	
SWEP	Benzene

SECTION XX- APPENDIX 6

Priority Pollutants Regulated in Organic Pesticide Chemicals Manufacturing Wastewaters Subcategory

2,4,5-T	Phenol 2,4-Dichlorophenol Toluene (plant 19 only)
TCMTB	Cyanide Methylene chloride
Tebuthiuron	Toluene
Temephos	1,2-Dichloroethane (plant 20 o Toluene (plant 21 only)
Terbacil	Methylene chloride Toluene
Terbufos	
Terbuthylazine	Cyanide
Terbutryn	Cyanide Toluene
Thiabendazole	Cyanide
Thiofanox	
Thionazin	1,2-Dichloroethane
Tokuthion	Phenol 2,4-Dichlorophenol Toluene
Toxaphene	Carbon tetrachloride Toxaphene Benzene (plant 22 only) Toluene (plant 22 only)
Triadimefon	Phenol
Tributyltin benzoate	
Tributyltin fluoride	
Tributyltin oxide	

SECTION XX- APPENDIX 6

Priority Pollutants Regulated in Organic Pesticide Chemicals Manufacturing Wastewaters Subcategory

Trichlorobenzene	Benzene Chlorobenzene 1,2,4-Trichlorobenzene
Trichloronate	2,4-Dichlorophenol Phenol Toluene
Tricyclazole	Benzene Toluene
Trifluralin	N-Nitrosodi-n-propylamine
Vancide TH	
Vancide 51Z	
Vancide 51Z dispersion	
Vancide PA	
Vernolate	Methylene chloride
Warfarin	
ZAC	Zinc
Zineb	Zinc
Ziram	Zinc (plants 23 and 24 only)

SECTION XX- APPENDIX 6

Priority Pollutants Regulated in Organic Pesticide Chemicals Manufacturing Wasters Subcategory

2 Regulated only in those processes in which it is the manufactured product.

3 Limits apply only for PSES, NSPS, and PSNS. BPT limits are established by 455.20(b).

Section XX-APPENDIX 7

Design Criteria for Recommended Technologies

Recommended Technology	Design Criteria
(1) Pump Station	8 Hours of Service Time Three Pumps at 50% of Total Flow Each Pumping Head=20 ft. Pump Efficiency=85% Wet Well Capacity=0.5% of Daily flow
(2) Equalization	Use at Least Two Basins Aeration and Mixing=75 HP/MG Detention Time Alternatives=12 Hours Before pretreatment) 24 Hours (Before Biological Treatment)
(3) Steam Stripping	Reflux ratio-0 Steam-to-feed ratio-0.10 Operating pressure=1.0 at Henry's Law Contant
(4) Chemical Oxidation	Use Two Batch Vessels with 24 HR. Detention Time Reaction Time=4 HR. Caustic Usage=3 Parts/Part CN Chlorine Usage=3 Parts/Part CN Operating Range=pH 8.5 to 11.0
(5) Metals Separation	Mixing Tank Detection Time=24 HR Mixing Horshepower=72 HP/MGD Filter Press Runtime=8 HR Holding Tank Detention Time=24 HR Operating pH=9.0 Influent Zinc=245 MG/l: Caustic Addition=6000 MG/l Influent Copper=4500 MG/l: Caustic Addition=110,000 MG/l
(6) Hydrolysis	Use Two Flow-Through Basins Basin Length/Width=20/1 Influent T=22°C=72°F Basin Length/Depth=20/1 Basin T = 40°C=104 Basin pH-11 Detention Time Alternatives

	0.28; 2.8; 6.9; 16.7 Days
(7) Neutralization	6 Min. Detention Time for Mixing Tank Caustic Addition=100 PPM Caustic Storage=30 Days
(8) Dual Media Filtration	Pumpung Head=20 Ft. Filter Rate=4 Gal/Min/Ft^2 Backwash 2 Filters At One Time Backwash Rate=20 Gal/Min/Ft^2 Backwash Head=30 FT. Run Length=12 Hours Backwash Duration=15 Min.
(9) Carbon Adsorption	Surface Loading=0.5 GPM/FT^2 (Primary Use) Surface Loading=4 GPM/FT^2 (Tertiary Use) Backwash Rate=20 GPM/FT^2 Two Columns in Series
(10) Carbon Regeneration	Carbon Usage Rate=20 lbs/1,000 gallons
(11) Resin Adsorption	Empty Bed Contact Time=15 Min Surface Loading=4 GPM/FT^2 Use Two Columns in Parallel, One Column Spare
(12) Resin Regeneration	Regeneration Frequency (Primary)= Twice Daily Solvent Loading=0.3 GPM/Ft^2 Pump Head=20 FT Methanol Loss=1% Yearly Batch Distillation Reflux Ratio=3/1
(13) Nutrient Addition	Maintain BOD/N/P=100/5/1
(14) Aeration Basin	Aeration=100 HP/MG Use Two Basins in Parallel
(15) Clarification	Overflow Rate=400 GPD/FT^2 Depth=12 Ft. Sludge Return Capacity=200% Minimum of Two Basins in Parallel
(16) Incineration	Chlorinated Organics pH Adjustment For Small Flows with Caustic Chlorinated Organics pH Adjustment for Large Flows with Lime Steam Recovery Included
(17) Sludge Thickening	Surface Loading=0.4 GPM/FT^2 Solid Loading=10 LB/FT^2/Day

	Influent=0.5% Solids Effluent=2.0% Solids
(18) Aerobic Digestion	Detention Time=20 Days Influent=2% Solids Effluent=3.5% Solids
(19) Vacuum Filtration	Ferric Chloride Addition=7% of Dry Solids Weight Effluent=15% Solids

SECTION XX — APPENDIX 8

NONCONVENTIONAL PESTICIDE POLLUTANTS ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated		Under Current EPA Review
	40 CFR Part 136	40 CFR Part 455	
Acephate	-	-	X
Alachlor	-	X	-
Aldicarb	-	-	X
Alkylamine hydrochlride	-	-	X
Ametryn	X	-	-
Amobam	-	-	X
Anilazine	-	-	-
AOP	-	X	-
Aquatreate DNM 30	-	-	X
Aspon	-	-	X
Atraton	X	-	-
Atrazine	X	-	-
Azinphos methyl	X	-	-
Barban	X	-	-
BBTAC	-	-	X
Bendiocarb	-	-	X
Benfluralin	-	X	-
Benomyl	-	X	-
Bensulide	-	-	X
Bentazon	-	X	-
Benzethonium Chloride	-	-	X
Benzyl bromoacetate	-	-	X
Bibenox	-	-	X
Biphenyl	-	-	X
Bolstar	-	X	-
Bromacil	-	X	-
Bromoxynil	-	-	X
Bromoxynil octanoate	-	-	X
Busan 40	-	X	-
Busan 85	-	X	-
Busan 90	-	-	X
Butachlor	-	X	-
Butylate	-	-	-

Note: 1. 40 CFR 136 as corrected on January 4, 1985 (50 CFR 691, 695)
2. 40 CFR 455 promulgated on August 31, 1985.

SECTION XX — APPENDIX 8

(Continued, Page 2 of 9)

NONCONVENTIONAL PESTICIDE POLLUTANTS ANALYTICAL METHOD AVAILABILITY/STATUS

	EPA Promulgated		Under Current
Pesticide	40 CFR Part 136	40 CFR Part 455	EPA Review
Captafol	-	-	X
Captan	X	-	-
Carbam-S	-	X	-
Carbaryl	X	-	-
Carbendazim	-	X	-
Carbofuran	-	X	-
Carbophenothion	X	-	-
CDN	-	-	X
Chloramben	-	-	X
Chlorobenzilate	-	X	-
Chloropicrin	-	-	X
Chlorothalonil	-	-	X
Chlorpyrifos	-	X	-
Chlorpyrifos methyl	-	X	-
Coumaphos	-	X	-
Cyanazine	-	X	-
Cycloate	-	-	X
Cycloheximide	-	-	X
Cycloprate	-	-	X
Cyhexatin	-	-	X
Cythioate	-	-	X
2,4-D	X	-	-
2,4-D isobutyl ester	X	-	-
2,4-D isooctyl ester	X	-	-
2,4-D salt	X	-	-
Dalapon	-	-	X
Dazomet	-	-	X
2,4-DB	-	X	-
2,4-DB isobutyl ester	-	X	-
2,4-DB isooctyl ester	-	X	-
DBCP	-	X	-
DCPA	-	-	X
D-D	-	-	X
Deet	-	X	-
Demeton (as Demeton-O and Demeton-S)	X	-	-
Diazinon	X	-	-
Dicamba	X	-	-
Dichlorfenthion	X	-	-

SECTION XX — APPENDIX 8

(Continued, Page 3 of 9)

NONCONVENTIONAL PESTICIDE POLLUTANTS ANALYTICAL METHOD AVAILABILITY/STATUS

	EPA Promulgated		
Pesticide	40 CFR Part 136	40 CFR Part 455	Under Current EPA Review
Dichloran	X	-	-
Dichlorophen salt	-	-	X
Dichlorprop	-	-	X
Dichlorvos	-	X	-
Dienochlor	-	-	X
Dimethoxane	-	-	X
Dinocap	-	-	X
Dinoseb	-	X	-
Dioxathion	X	-	-
Diphacinone	-	-	-
Diphenamid	-	-	X
Disulfoton	X	-	-
Diuron	X	-	-
Dodine	-	-	X
Dowicil 75	-	-	X
Endothall	-	-	X
EPN	-	-	X
EPTC	-	-	X
Ethalfluralin	-	X	-
Ethion	X	-	-
Ethoprop	-	-	X
Ethoxyquin 66%	-	-	X
Ethoxyquin 86%	-	-	X
Ethylene dibromide	-	-	X
Etridiazole	-	X	-
EXD	-	-	X
Famphur	-	-	X
Fenarimol	-	-	X
Fenitrothion	-	-	X
Fensulfothion	-	X	-
Fenthion	-	X	-
Fentin hydroxide	-	-	X
Ferbam	-	X	-
Fluchloraline	-	-	X
Fluoridone	-	-	X
Fluometuron	-	X	-
Fluroacetamide	-	-	X
Folpet	-	-	X
Fonofos	-	-	X
Giv-gard	-	-	X

SECTION XX — APPENDIX 8

(Continued, Page 4 of 9)

NONCONVENTIONAL PESTICIDE POLLUTANTS ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated		Under Current EPA Review
	40 CFR Part 136	40 CFR Part 455	
Glyodin	-	-	X
Glyphosate	-	X	-
HAE	-	-	X
HAMP	-	-	X
Hexachlorophene	-	-	X
Hexazinone	-	X	-
HPTMS	-	-	X
Hyamine 2389	-	-	X
Hyamine 3500	-	-	X
Isodrin	X	-	-
Isopropalin	-	X	-
Kathon 886	-	-	X
Kinoprene	-	-	X
KN Methyl	-	X	-
Lethane 384	-	-	X
Linuron	X	-	-
Malathion	X	-	-
Maleic hydrazide	-	-	X
Mancozeb	-	X	-
Maneb	-	X	-
MCPA	-	-	X
MCPA isooctyl ester	-	-	X
MCPP	-	-	X
Mephosfolan	-	X	-
Merphos	-	-	X
Metasol DGH	-	-	X
Metasol J-26	-	-	X
Metham	-	X	-
Methamidophos	-	-	X
Methomyl	-	X	-
Methoprene	-	-	X
Methoxychlor	X	-	-
Methylbenzethonium chloride	-	-	X
Methylene bisthiocyanate	-	-	X
Metribuzin	-	X	-
Mevinphos	-	X	-
MGK 264	-	-	X
MGK 326	-	-	X
Molinate	-	-	X
Monocrotophos	-	-	X

(Continued, Page 5 of 9)

NONCONVENTIONAL PESTICIDE POLLUTANTS ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated 40 CFR Part 136	EPA Promulgated 40 CFR Part 455	Under Current EPA Review
Nabam	-	X	-
Nabonate	-	-	X
Naled	-	X	-
Napropamide	-	-	X
Naptalam	-	-	X
Niacide	-	X	-
Nitrofen	-	-	X
NMI	-	-	X
Norflurazon	-	-	X
Octhilinone	-	-	X
Oryzalin	-	-	X
Oxamyl	-	X	-
Oxydemeton	-	-	X
Oxyfluorfen	-	-	X
Paraquat	-	-	X
Parathion ethyl	X	-	-
Parathion methyl	X	-	-
PBED	-	-	X
PCNB	X	-	-
PCP salt	X	-	-
Pebulate	-	-	X
Permethrin	-	-	X
Phenylphenol	-	-	X
Phenylphenol sodium salt	-	-	X
Phorate	-	X	-
Phosfolan	-	-	X
Phosmet	-	-	X
Picloram	-	-	X
Pindone	-	-	X
Piperalin	-	-	X
Piperonyl butoxide	-	-	X
Polyphase antimildew	-	-	X
Profluralin	-	X	-
Prometon	X	-	-
Prometryn	X	-	-
Pronamide	-	-	X
Propachlor	-	X	-
Propanil	-	-	X
Propargite	-	-	X

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NONCONVENTIONAL PESTICIDE POLLUTANTS ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated 40 CFR Part 136	EPA Promulgated 40 CFR Part 455	Under Current EPA Review
Propazine	X	-	-
Propionic acid	-	-	X
Pyrethrins	-	-	X
8 Quinolinol citrate	-	-	X
8 Quinolinol sulfate	-	-	X
Resmethrin	-	-	X
RH 787	-	-	X
Ronnel	-	X	-
Rotenone	-	-	X
Secbumeton	X	-	-
Siduron	X	-	-
Silvex (2,4,5-TP: silvex)	X	-	-
Silvex isooctyl ester	X	-	-
Silvex salt	X	-	-
Simazine	X	-	-
Simetryne	-	X	-
Sodium monofluroacetate	-	-	X
Striofos	-	X	-
Strobane	X	-	-
Sulfallate	-	-	X
2,4,5-T	X	-	-
TCMTB	-	-	X
Tebuthiuron	-	-	X
Temephos	-	-	X
Terbacil	-	X	-
Terbufos	-	X	-
Terbuthylazine	X	-	-
Terbutryn	-	X	-
Thiabendazole	-	-	X
Thiofanox	-	-	X
Thionazin	-	-	X
Tokuthion	-	-	X
Triadimefon	-	X	-
Tributyltin benzoate*	-	-	X
Tributyltin fluoride*	-	-	X
Tributyltin oxide*	-	-	X
Trichloronate	-	X	-
Tricyclazole	-	X	-
Trifluralin	X	-	-

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NONCONVENTIONAL PESTICIDE POLLUTANTS ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated 40 CFR Part 136	 40 CFR Part 455	Under Current EPA Review
Vancide PA	-	-	X
Vancide TH	-	-	X
Vancide 51Z**	-	-	X
Vancide 51Z dispersion**	-	-	X
Vernolate	-	-	X
ZAC	-	X	-
Zineb	-	X	-
Ziram	-	X	-

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NONCONVENTIONAL PESTICIDE POLLUTANTS ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated 40 CFR Part 136	EPA Promulgated 40 CFR Part 455	Under Current EPA Review
Pesticides Previously Regulated But Currently Not Manufactured			
Aminocarb	X	-	-
Chlorpropham	X	-	-
Demeton-o	X	-	-
Demeton-s	X	-	-
Dicofol	X	-	-
Fenuron	X	-	-
Fenuron-TCA	X	-	-
Methiocarb	X	-	-
Mexacarbate	X	-	-
Mirex	X	-	-
Monuron	X	-	-
Monuron-TCA	X	-	-
Neburon	X	-	-
Perthane	X	-	-
Propham	X	-	-
Propoxur	X	-	-
Swep	X	-	-

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NONCONVENTIONAL PESTICIDE POLLUTANTS ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated 40 CFR Part 136	EPA Promulgated 40 CFR Part 455	Under Current EPA Review
Pesticides Excluded from BPT and Currently Not Manufactured			
Alletrin	-	-	X
Benzyl benzoate	-	-	X
Chlorophacinone	-	-	X
Coumachlor	-	-	X
Coumafuryl	-	-	X
Coumatetralyul	-	-	X
1,8-Naphthalic anhydride	-	-	X
Quinomethionate	-	-	X
Sulfoxide	-	-	X
Warfarin	-	-	X
Total Number of Pesticides	59	61	148

* Pesticides may be monitored by analysis for Tin using analytical methods promulgated at 40 CFR Part 136.

** Pesticides may be monitored by analysis for Zinc using analytical methods promulgated at 40 CFR Part 136.

Section XX - APPENDIX 9

List of Approved Test Procedures for Nonconventional Pesticide Pollutants Promulgated at 40 CFR Part 455

Parameter (1)	CAS No.	EPA Method Number (2)	Other
1. Alachlor	15972-60-8		102
2. AOP	(NA)	630	
3. Benfluralin	1861-40-1	627	
4. Benomyl	17804-35-2	631	
5. Bentazon	25057-89-0		107A
6. Bolstar	35400-43-2	622	
7. Bromacil	314-40-9	633	
8. Busan 40	51026-28-9	630	
9. Busan 85	128-03-0	630	
10. Butachlor	23184-66-9		102
11. Carbam-S	128-04-1	630	
12. Carbendazim	10605-21-7	631	
13. Carbofuran	1563-66-2	632	
14. Chlorobenzilate	510-15-6	608.1	
15. Chloropyrifos	2921-88-2	622	
16. Chloropyrifos Methyl	5598-13-0	622	
17. Coumaphos	56-72-4	622	
18. Cyanazine	21725-46-2	629	
19. 2,4-DB	94-82-6	615	
20. 2,4-DB isobutyl ester	533-74-4	615	
21. 2,4-DB isooctyl ester	1320-15-6	615	
22. DBCP	96-12-8	608.1	
23. DEET	134-62-3	633	
24. Dichlorvos	62-73-7	622	
25. Dinoseb	88-85-7	615	
26. Ethalflurlin	55283-68-6	627	
27. Etridiazole	2593-15-9	608.1	
28. Fensulfothion	115-90-2	622	
29. Fenthion	55-38-9	622	
30. Ferbam	14484-64-1	630	
31. Fluometuron	2164-17-2	632	
32. Glyphosate	1071-83-6		140A
33. Hexazinone	51235-04-2	633	
34. Isopropalin	33820-53-0	627	
35. KN Methyl	(NA)	630	
36. Mancozeb	8018-01-7	630	
37. Maneb	12427-38-2	630	
38. Mephosfolan	950-10-7		130
39. Metham	137-42-8	630	
40. Methomyl	16752-77-5	632	
41. Metribuzin	21087-64-9	633	
42. Mevinphos	7786-34-7	622	
43. Nabam	142-59-6	630	

44.	Naled	300-76-5	622	
45.	Niacide	15339-36-3	630	
46.	Oxamyl	23135-22-0	632	
47.	Phorate	298-02-2	622	
48.	Profluralin	26399-36-0	627	
49.	Propachlor	1918-16-7	608.1	102
50.	Ronnel	299-84-3	622	
51.	Simetryne	1014-70-6	619	
52.	Stirofos	961-11-5	622	
53.	Terbacil	5902-51-2	633	
54.	Terbufos	13073-79-9		130
55.	Terbutryn	886-50-0	619	
56.	Triadimefon	43121-43-3	633	
57.	Trichloronate	327-98-0	622	
58.	Tricyclazole	41814-78-2	633	
59.	ZAC	(NA)	630	
60.	Zineb	12122-67-7	630	
61.	Ziram	137-30-4	630	

(NA) = Not Available

(1) All parameters are expressed in micrograms per liter (52/L)

(2) The full text of methods 102, 107A, 130, 140A, 608.1, 615, 619, 622, 627, 629 630, 631, 632, and 633 are given at Appendix E, "Text Procedures for Analysis of Nonconventional Pesticide Pollutants" of this Part 455. The standardized test procedure to be used to determine the method detection limit (MDL) for these test procedures is given at Appendix B, "Definition and Procedure for the Determination of the Method Detection Limit" of 40 CFR Part 136.

Section XX - APPENDIX 10

Priority Pollutants and Subcategories Excluded

1. Priority Pollutants Excluded

I. Subcategory 1 - Organic Pesticide Chemicals Manufacturing

Under Paragraphs 8(a)(iii) and 8(b)(i) of the Settlement Agreement, EPA is excluding certain toxic pollutants from regulation in the Organic Pesticide Chemicals Manufacturing Subcategory, for one or all of the following reasons:

(a) The pollutant is not detectable in the effluent with the use of analytical methods approved pursuant to 304(h) of the Act or other state of the art methods.

(b) The pollutant is present only in trace amounts and is neither causing nor likely to cause toxic effects.

(c) The pollutant is present in amounts too small to be effectively reduced by technologies known to the Administrator.

(d) The pollutant will be effectively controlled by the technologies upon which are based other effluent limitations and guidelines, standards of performance, or pretreatment standards

(e) The pollutant is detectable in the effluent from only a small number of sources within the subcategory and the pollutant is uniquely related to only those sources.

(f) Ninety-five percent or more of all point sources in the subcategory introduce into POTWs only pollutants which use susceptible to treatment by the POTW and which do not interfere with, do not pass through or are not otherwise incompatible with such treatment works.

A. Excluded from the BAT, NSPS, PSES, and PSNS regulations with the reasons(s) for each of the exclusions keyed to the above list:

Volatile Aromatics
- 1,3-Dichlorobenzene (d)
- Ethylbenzene (d)
- Hexachlorobenzene (d)

Haloethers
- Bis(2-chloroethoxy)methane (b)

Bis(2-chloroisopropyl)ether (b)
4-Bromophenyl phenyl ether (b)
2-Chloroethyl vinyl ether (b)
4-Chlorophenyl phenyl ether (b)

Halomethanes
- Chlorodibromomethane (a)
- Dichlorobromomethane (a)
- Tribromomethane (d)

Phenols
- 2-Chlorophenol (d)
- 2,4-Dimethylphenol (d)
- 4,6-Dinitro-o-cresol (a)
- 2-Nitrophenol (d)
- Parachlorometacresol (d)
- 2,4,6-Trichlorophenol (d)

Nitrosubstituted Aromatics
- 2,4-Dinitrotoluene (a)
- 2,6-Dinitrotoluene (a)
- Nitrobenzene (a)

Polynuclear Aromatic Hydrocarbons
- Acenaphtylene (b)
- Acenaphthene (b)
- Anthracene (b)
- Benzo(a)anthracene (a)
- Benzo(a)pyrene (a)
- 3,4-Benzofluoranthene (a)
- Benzo(ghi)perylene (a)
- Benzo(k)fluoranthene (a)
- 2-Chloronaphthalene (e)
- Chrysene (a)
- Dibenzo(a,h)anthracene (a)
- Fluoranthene (b)
- Fluorene (b)
- Indeno(1,2,3-cd)pyrene (a)
- Napthalene (e)
- Phenathrene (b)
- Pyrene (a)

Metals
- Arsenic (c)
- Antimony (c)
- Beryllium (c)
- Cadmium (c)
- Chromium (c)
- Lead (c)
- Mercury (c)
- Nickel (c)
- Selenium (c)
- Silver (c)
- Thallium (c)

Chlorinated Ethanes and Ethylenes
- Chloroethane (d)
- 1,1-Dichloroethane (d)
- 1,1-Dichloroethylene (d)
- Hexachloroethane (d)
- 1,1,2,2-Tetrachloroethane (d)
- 1,2-trans-Dichloroethylene (d)
- 1,1,1-Trichloroethane (d)
- 1,1,2-Trichloroethane (d)
- Trichloroethylene (d)
- Vinyl chloride (d)

Nitrosamines
- N-nitrosodimethylamine (d)
- N-nitrosodiphenylamine (a)

Phthalate Esters
- Bis(2-ethylhexyl)phthalate (a)
- Butyl benzyl phthalate (b)
- Diethy phthalate (b)
- Dimethyl phthalate (e)
- Di-n-butyl phthalate (b)
- Di-n-octyl phthalate (a)

Pesticides
- Aldrin (a)
- Chlordane (e)
- Dieldrin (a)
- 4,4'-DDD (a)
- 4,4'-DDE (a)
- 4,4'-DDT (a)
- Endosulfan sulfate (a)
- Endrin aldehyde (d)
- Heptachlor epoxide (d)

Dichloropropane and Dichloropropene
- 1,2-Dichloropropane (b)

TCDD
- TCDD (a)

Dienes
- Hexachlorobutadiene (d)

Miscellaneous
- Acrolein (a)
- Acrylonitrile (e)
- Asbestos (a)
- 1,2-Diphenylhydrazine (a)
- Isophorone (a)

Polychlorinated Biphenyls
- PCB - 1242 (a)
- PCB - 1254 (a)
- PCB - 1221 (a)

PCB - 1232 (a)
PCB - 1248 (a)
PCB - 1260 (a)
PCB - 1016 (a)

Benzidines
Benzidine (a)
3,3'-Dichlorobenzidine (a)

B. Excluded from the BAT regulation for reason (d) above:

a-BHC-Alpha
b-BHC-Beta
d-BHC-Delta
g-BHC-Gamma (Lindane)
a-Endosulfan-Alpha
b-Endosulfan-Beta
Endrin
Heptachlor
Toxaphene

C. Excluded from PSES regulation for reason (f) above:

1,2-dichloroethane
chlorobenzene
tetrachloroethylene
toluene
benzene
phenol

II. Subcategory 2 - Metallo-Organic Pesticide Chemicals Manufacturing

In the metallo-organic pesticide chemicals subcategory, in the mercury-organic pesticide segment, the Agency is excluding zinc from the PSES regulation under paragraph 8(a)(iii) because the pollutant is present in the effluent from only one source and is uniquely related to only that source. (reason (e) in I. above).

2. Subcategories Excluded

The Agency is excluding the metallo-organic pesticide chemicals manufacturing and the pesticide chemicals formulating and packaging subcategories from national BAT regulation development under Paragraph 8(a)(i) of the Settlement Agreement because the existing BPT effluent limitations guidelines provide equal or more stringent protection. BPT requires no discharge of process wastewater pollutants for those two subcategories.

The Agency is excluding the metallo-organic pesticide chemicals manufacturing subcategory from further national NSPS and PSNS regulation development under Paragraph 8(a)(iv) and 8(b)(i) because of the small potential number of sources.

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